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ABSTRACT

A computer selection committee was charged with studying the computer needs of Andrews University in Berrien Springs, Michigan. Major results of the investigation included the findings that campus academic and administrative needs would best be served by one onsite system which could support versatile and concurrent time-sharing, batch processing, batch multiprograming and input/output spooling and also be capable of processing 100,000 character batch programs. Purchase of the Xerox Sigma 6 system was recommended on the basis of its hardware and software capabilities, vendor support, system growth options and cost. Total monthly cost, including equipment and maintenance, was estimated at $10,500. It was further recommended that non-standard contractual arrangements be negotiated with Xerox to cover the University's particular needs for maintenance service and personnel, systems analysis personnel, spare parts storage, upgrading of the system and provision of a new style memory. Additional studies of methods of procuring terminals and of modifying physical plant facilities were noted as being necessary and it was recommended that the University hire a computer consultant. (Author/PB)

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REPORT OF COMPUTER SELECTION STUDY COMMITTEE

LeRoy H. Botten

Andrews University
Berrien Springs, Michigan

Computing Center

Revised: December 13, 1973

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LeRoy H. Botten

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Andrews University
Berrien Springs, Michigan

Computing Center
Revised: December 13, 1973

NOTICE

This report has been edited to delete proprietary information provided by certain vendors. The original report was intended only for internal use at Andrews University.

SUMMARY

This report summarizes the results of approximately nine man-months of study by the Computer Selection Committee appointed on August 7, 1972, by President Hammill. A summary of major findings and recommendations is presented below. Further recommendations and justification are contained in the body of this report.

FINDINGS

- Cost factors indicate that total university needs can best be served by one computer system serving both academic and administrative users.
- Academic and administrative computing requirements include support of versatile timesharing, support of concurrent timesharing and batch processing, support of batch multiprograming, support of input-output spooling, and capability to process 100,000 character batch programs.
- The cost of an adequately configured IBM 370/135 is prohibitively high regardless of financing method.
- The cost of commercial timesharing services is significantly higher than similar services provided by an

on-site computer system.

- The Selection Committee was asked to evaluate several plans involving the expansion of the presently installed IBM 360/22. Even with the maximum possible system expansion of the IBM 360/22, resultant systems fail to provide adequate batch or timesharing capabilities.
- The Xerox Sigma 6 computer system, described in the report, best meets the needs of Andrews University on the basis of demonstrable system hardware and software capability, vendor software support, vendor maintenance support, vendor conversion support, system growth options, financial arrangements, and total cost.
- Present Computing Center staffing is not adequate to meet academic needs.

RECOMMENDATIONS

- Xerox should be designated as the vendor to supply computing equipment and related services required by Andrews University.
- Negotiations should be initiated with Xerox representatives to finalize the following:
    a. An installment purchase contract to purchase the proposed Sigma 6 computer system (less printer and unit record devices) for delivery prior to June 15, 1973. The anticipated cost (based on six per-

cent simple interest on the unpaid balance) is $5,995 per month.

   b. A lease of the unit record and printer subsystems (card reader, card punch, and printer). The anticipated cost is $1,836 per month.
   c. A maintenance contract for purchased equipment. The anticipated cost is $2,650 per month.
   d. A conversion services contract. Anticipated total cost is $1,300.
   e. Installation, conversion, and training schedules.

- In order to answer specific needs of Andrews University, certain non-standard contractual arrangements should be negotiated with Xerox:
   a. Location of nearest maintenance personnel, systems analyst personnel, and spare parts storage facility.
   b. An agreement to subsequently upgrade the purchased portion of the selected system.
   c. An agreement to provide maintenance service on the installed system for the duration of the installment purchase contract at guaranteed rates.
   d. An agreement to provide "new style" memory.
- Standard Xerox contracts for lease, installment purchase, and maintenance should be evaluated by a commercial lawyer for potential sources of difficulty. Final contracts should be reviewed by a commercial lawyer prior to acceptance.

- The contractural arrangements made with Xerox should bear the name of General Conference Corporation of Seventh-day Adventists rather than Andrews University Corporation. If this is not feasible, a non-standard agreement should be made with Xerox to permit transfer of the system to any other denominational affiliate at our discretion.
- A study of optimum methods of procuring terminals (as outlined in Section 5), a plotter, and an optical page reader should be conducted as a supplement to the computer selection study. This study should also isolate requirements for disk packs, tapes, and storage facilities and optimum methods for procurement.
- A study of required physical plant modifications should be instituted as a supplement to the computer selection study. At this time it appears as if no structural modifications will be necessary.
- Steps should be taken promptly to hire a qualified academic consultant.
- All Magnetic Card Selectric Typewriter systems on campus should be replaced by 2741-like terminals as soon after system installation as practicable.

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Section 1

INTRODUCTION

> It is unworthy of excellent men to
> lose hours like slaves in the labor
> of calculation.
>
> —Gottfried Wilhelm Leibniz

1.1 INTRODUCTION

Leibniz recognized as early as 1697 that considerable creative power was wasted in tedious calculations. Today the computer has relieved such burdens in diverse fields, and the extension of human capabilities made possible by computing systems has made them a part of everyday life in our society. Whether a student will require detailed knowledge of computer systems as a tool in his professional arsenal or merely a familiarity as part of a liberal education, there are few students who cannot benefit from exposure to the use of a digital computer system. In many disciplines such experience is an integral part of a quality education.

The acceptance of a computing system by students and faculty is largely dependent on ease of use of the system. In evaluating ease of use factors, the Selection Committee has found the most significant single factor to be provision for timesharing. Timesharing (the use of a computer from remote

Section 2

THE STUDY

2.1 THE COMMITTEE

On August 7, 1972, a committee was appointed by President Richard Hammill to study requirements for academic computing at Andrews University. The members of the committee include:

Charles Clark, Chairman
John Beach
LeRoy Botten
Don Engelkemier
Dwain Ford
Wilfred Futcher
Robert Kingman
Gordon Madgwick
Lawrence McNitt
Joseph Smoot

A copy of the letter of appointment is included as Appendix B.

2.2 INITIAL SCOPE OF THE STUDY

The letter of appointment (Appendix B) charged the committee with four major tasks:

- Determine the requirements, versus the desires and ideas, of the academic departments for both interactive remote terminals and batch processing for instruction and research by faculty and students.
- Project the work load requirements for both batch and terminal processing for the next five years.
- Evaluate the five alternatives discussed in Charles Clark's letter of July 24, 1972, for providing interactive terminal facilities. Charles Clark's letter is an enclosure to the letter of appointment (Appendix B). Special attention should be given to the possibility of expanding the IBM 360/22.
- Evaluate the advisability of a "Third Party Lease" in lieu of a vendor lease or purchase.

2.3 EXPANDED SCOPE OF THE STUDY

Although the initial intent of the study was to evaluate academic needs, the committee determined that there are several necessary adjuncts to the assigned tasks:

- Determine business and administrative processing requirements for the next five years.
- Investigate software and hardware necessary to implement required business and academic processing.

- Investigate recent changes in economics of computer procurement, and probable future developments, in relation to the needs of Andrews University.
- Investigate staffing requirements to support expanded academic usage of the computing system.
- Make a thorough economic analysis of various methods of satisfying computing requirements at Andrews University.

These investigations were included in the study.

2.4 METHODS USED IN CONDUCTING THE STUDY

2.4.1 Direct Faculty Contacts

It is the consensus of the committee that the proper procedure for defining hardware requirements is to first define the required applications, then determine software necessary to implement the applications, and finally establish hardware requirements necessary to implement the software. Meetings were held with the individual faculties of most departments to obtain, directly, information on required and desired applications. The committee evaluation of this information is attached as Appendix C. Certain system criteria were also established as a result of this information (see Section 2.5).

2.4.2 Publications

Data-Pro 70, Auerbach Computer Technology Reports, and various other trade publications were used to verify and supplement information furnished by vendors. Copies of reports for the recommended system are attached as Appendix D.

2.4.3 Vendor Contacts

Based on software requirements determined by the study, vendors were asked to propose a hardware system to implement the required software.

2.4.4 Initial Rating of Proposals

Although 22 systems had been initially proposed, all but eight were eliminated on the basis of obvious failure to meet established criteria. The eight remaining systems were evaluated in detail. The rating system and results are briefly described in Appendix E.

2.4.5 Consultation

The results of the initial rating of the proposals were discussed with an outside consultant who concurred largely with those results. The consultant has been available on a continuing basis throughout the study.

2.4.6 Other Studies

The committee has had access to information derived from studies by Philco-Ford, Hope College, and Grand Valley College. These independent studies generally validated the findings of the committee.

2.4.7 Reference Accounts

Liberal use has been made of information provided by reference accounts furnished by vendors as well as information furnished by users located by other means. Unbiased observations by users have been valuable in both discounting and verifying various vendor claims for system performance. Reference accounts have been especially useful in estimating staffing requirements.

2.4.8 Economic Stability Analysis

A. Klein, of the Business and Administration Department, made a study of the corporate stability of several vendors of interest. The results of his study are attached as Appendix F.

2.4.9 Benchmark Study

A request for benchmark study was submitted to each of eight vendors as means of further validating and supplementing the evaluation described in Section 2.4.4. A copy of the request for benchmark study is attached as Appendix G, and results are summarized in Section 4.

2.4.10 Communications Study

In order to make a meaningful recommendation for a computing system, it is necessary to consider the basic system hardware in relation to communications requirements. The communications study includes consideration of number, type, and placement of remote terminals and remote job entry devices on campus or at distant locations; consideration of CPU to CPU communications (ie., networks); and consideration of methods and costs for data transmission to remote sites. Results are summarized in Section 5.

2.4.11 Demonstration

Prior to entering contract negotiations a trip to an installation similar to that recommended for Andrews University was made. Such a trip permitted representatives of Andrews University to talk to their counterparts at the visited installation to obtain evaluations of the system from their own particular viewpoints.

2.4.12 Contract Studies

Prior to entering contract negotiations it is important to review standard vendor contracts for the proposed system and study non-standard riders which should be requested during negotiations. Copies of the standard contracts for the recommended system, and Andrews University legal counsel opinion on those contracts, are attached as Appendix H. As a part of contract negotiations, a thorough review of the proposed configuration must be made.

2.5 CRITERIA AND SPECIFICATIONS

In order to meet the academic and business computing needs of Andrews University as identified by the Study Committee, a satisfactory system must meet at least the following criteria:

- Total monthly cost for system and maintenance must not exceed a nominal value of $10,000.
- The system must support concurrent timesharing and batch processing.
- The system must support demonstrable ANSI COBOL, BASIC, ANSI FORTRAN, and load-and-go FORTRAN compilers.
- The system must support an adequate simulation and modeling language, and an adequate string manipulation language.
- The system must support adequate statistical and scientific subroutine packages.
- The system must support an adequate text editor and data base management system.
- The system must be available for delivery prior to June 15, 1973.
- The system must support spooling and batch multiprograming. In a dedicated batch mode, user core area must be at least 100 K bytes (the minimum necessary to execute many standard statistical packages).

- The timesharing capability must include excellent file security features.
- The system must support nine track tapes.
- The proposed system must be capable of expansion to at least 256 K bytes main memory, 200 M bytes disk storage, and 40 communications ports.
- The vendor must be able to provide excellent maintenance support.
- The system must support existing applications.
- The internal code must be consistent with current internal code standards (ie., 8 bit internal code).
- The system must include an adequate swapping device.
- The vendor must present an acceptable conversion plan.

2.6 DOCUMENTATION AND COMPLETENESS

Although major recommendations and conclusions of this report are supported by documentation in the form of appendices, that documentation is not exhaustive. In attempting to keep the report concise much of the available documentation has been omitted.

Similarly, recommendations and conclusions are often presented without exhaustive justification.

Every effort has been made to avoid "loose-ends." even though that may not always be obvious from this report. The Selection Committee is fully prepared to offer more complete documentation and discussion as required.

typewriter-like terminals) permits each user to feel as if he is using a dedicated machine. The conversational nature of timesharing systems allows even inexperienced non-technical persons to write simple programs with a minimum of exposure to the system. In many cases existing programs may be stored by the instructor and used immediately by students.

Timesharing also offers major advantages to business and administrative users. For example, use of timesharing for student and financial records, inventory control, and other systems, permits reductions in expense for data preparation and major improvements in accessibility of information.

For student and faculty research in the physical sciences, the behavioral sciences, education, and other disciplines, requirements also exist for large scale batch processing. At present, Andrews University is purchasing such services from Notre Dame and Whirlpool Corporation. Unfortunately, obtaining such outside services involves long delays and considerable expense. An increased batch processing capability is also required if certain proposed administrative work (NCHEMS model; trust accounting) is to be done.

Computing should be viewed not only as a tool to relieve drudgery but as a new learning resource--one capable of improving both the scope and quality of education.(1)

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(1) See Appendix A for more detailed comments on uses of the computer in higher education.

Section 3

INITIAL RATING OF PROPOSALS

3.1 SYSTEMS RATED

Eight systems were chosen for detailed evaluation, and each major vendor of computing machinery is represented except for Control Data Corporation (CDC elected not to submit a proposal). In order to make meaningful comparisons between systems, the systems rated were configured as nearly alike as possible. The systems rated are listed below. (The numbers listed represent the number of characters of main storage and disk storage respectively):

- Burroughs B5500 (256K, 48M)
- Digital Equipment Corporation DEC1040 (320K, 100M)
- Hewlett-Packard HP3000 (131K, 94M)
- Honeywell Information Systems 430 (131K, 92M)
- International Business Machines 370/125 (131K, 200M)
- National Cash Register Century 200 (128K, 90M)
- Univac 70/46 (262K, 118M)
- Xerox Data Systems Sigma 6 (192K, 100M)

3.2 RATING METHOD

3.2.1 Summary

Detailed information provided by vendors was categorized and evaluated in detail by the committee. Each area was evaluated on a scale of zero (unsatisfactory) to seven (outstanding) and that score multiplied by a weighting factor to arrive at point scores. Point scores were grouped into five major categories--the major categories were then weighted such that their contribution to a total point score is as follows:

- Hardware Capabilities (20%)
- Growth Potential (15%)
- Operating System (20%)
- Languages (20%)
- Conversion, Maintenance and Software Support (25%)

A summary of scores in the major areas and total score, by system, is given in Appendix E. The maximum possible score is 700.

3.2.2 Comments Regarding the Rating System

The major strength of the rating system is that it permits the many characteristics of complex systems to be broken into small groups which can be realistically evaluated. The major weaknesses of the rating system were that evaluations were largely based on unverified sales presentations and that evaluations of quality of applications software could not be included in the rating.

It is worth noting that relying on sales presentations at this point in the study does itself offer one advantage--it is unlikely that the "best choice" will be overlooked. It is the function of benchmark programs, reference accounts, demonstrations, and acceptance test standards to ensure that a system is chosen on the basis of demonstrable characteristics rather than just a well made sales presentation.

3.2.3 Results of Initial Rating

Based on the rating system described, the systems were ranked as follows (the numbers listed are total weighted point scores):

- Digital Equipment Corporation DEC1040 (500)
- Hewlett-Packard H-P3000 (483)
- Xerox Data Systems Sigma 6 (471)
- Burroughs B5500 (442)
- Univac 70/46 (441)
- International Business Machines 370/125 (426)
- Honeywell Information Systems 430 (363)
- National Cash Register Century 200 (325)

The above ranking does not include consideration of system cost. Since Appendix E was prepared, several vendors have resubmitted proposals with substantial price reductions or significant performance enhancements.

3.2.4 Proposals Eliminated Prior to Benchmark Study

Due to results of the initial rating of proposals and continuing reference account calls, it was found that several proposals did not meet required criteria. Those systems are as follows:

- HP3000: adequate COBOL not demonstrable.
- B5500: can only support 7 track magnetic tapes; six bit machine; concurrent processing is questionable; COBOL of questionable adequacy.
- IBM 370/125: system not available until fourth quarter 1973 or first quarter 1974; operating system proposed will not be released until June 1973; timesharing capability of this system is very limited in versatility and number of simultaneous users; proposed system has maximum possible main memory; load-and-go FORTRAN not available for the proposed system.
- HIS 430: concurrent processing is very questionable; six bit internal code.
- NCR 200: although a very fine machine for many commercial applications, the NCR 200 lacks the versatility required to serve needs of Andrews University; concurrent processing is questionable.

3.2.5 Standing of Proposals Prior to Benchmark Study

Although the study committee would estimate an uncertainty of perhaps

30 points in the total point scores, there does appear to be a fairly well defined ranking of proposed systems as a result of the initial rating of proposals:

- DEC 1040 (500)
- XDS Sigma 6 (471)
- Univac 70/46 (441)

It should be stressed that the rating was based on a smaller Sigma 6 configuration, and a different operating system, than was finally purchased. If the rating were to be repeated the Sigma 6 system, with CP-V operating system, would clearly have the highest score.

Section 4

BENCHMARK STUDY

4.1 INTRODUCTION

A benchmark study begins with submission of a series of selected programs to vendors to be compiled and executed on proposed systems. In a strictly commercial environment, analysis of the benchmark study usually emphasizes measures of throughput. However, in a university environment system versatility and user convenience are more important than raw throughput. Certainly commercial applications are important at Andrews University, for that reason much of the benchmark study is dedicated to assessing proposed system capabilities in the administrative and business processing areas. A copy of the Request For Benchmark is enclosed as Appendix G.

Conducting a benchmark study is very expensive for a vendor. Vendors whose proposals had been tentatively eliminated during the initial rating were so notified in order to aid them in deciding whether or not to respond. In fairness, and to allow a vendor who felt our initial rating did not reflect the actual capabilities of the system rated, all vendors were given a copy of the Request For Benchmark. The letters of transmittal stated that those systems not previously eliminated must be benchmarked to remain in the competition and that, for those proposals tentatively eliminated, we would reevaluate our decision should the benchmark indicate the prior analysis was in error.

4.2 RESPONSES

Only two vendors responded to the benchmark request in a timely and reasonably complete manner: Univac and Xerox. Digital Equipment Corporation responded to only part of the BASIC and FORTRAN tests (and that response was a week late). No other responses were received. The Xerox and Univac benchmark reports are attached as part of Appendix G.

4.3 BENCHMARK CONFIGURATIONS

Univac used the system proposed for installation at Andrews University to run the benchmark. Xerox used an exactly equivalent system except for the following:

Item	Test System	Proposed System
Card Reader	7140 (1500 CPM)	7122 (400 CPM)
Card Punch	7160 (300 CPM)	7165 (100 CPM)
Line Printer	7445 (1000 LPM)	7441 (1100 LPM)

Although the card reader and card punch used were more capable, the test programs were not sensitive to card input-output operations. The line printer used has been superseded by the model proposed (the proposed model is faster and should produce printed copy of higher quality). The results obtained from the Univac and Xerox benchmark tests can be expected to compare very closely to the systems proposed.

4.4 CONVERSION TEST

Conversion of benchmark programs was done by Univac and Xerox. Although programs were derived from a variety of sources, neither vendor had apparent difficulty in compiling and executing test programs with a minimum of effort.

4.5 DEDICATED MACHINE PERFORMANCE TESTS

This series of tests was designed to measure throughput capabilities of the proposed systems for COBOL, FORTRAN, and BASIC programs. Since the Request for Benchmark (Appendix G) explicitly defines the tests, only a summary of results will be provided here.

Since certain times provided by Univac were specified with limited accuracy, only execution times will be compared for this part of the analysis.

4.5.1 Timesharing Mode

Comparisons with IBM 360/22 cannot be made since timesharing is not possible on the 360/22.

Execution Time (seconds)

Program	Univac 70/46	Xerox Sigma 6
B8	183.7	40.5
F1	81.0	14.5
C1	59.3	108.5

4.5.2 Batch Mode

No batch BASIC capability exists for the Univac and IBM 360/22 systems.

Execution Time (seconds)

Program	Univac 70/46	Xerox Sigma 6
B8	----	38.0
F1	81.6	14.5
C1	60.0	108.5

4.5.3 Conclusions

Note that little difference exists between timings for execution of batch and timesharing work. Although the Univac data, as specified is too imprecise to justify detailed comparisons, the Xerox system does appear to have much shorter compile times in general.

BASIC program B8 was designed to test looping and calculational speed. The Xerox B8 executes in only 22% of the time required to execute Univac B8 (about 4.5 times faster).

FORTRAN program F1 was designed to test looping and calculational speed. The Xerox F1 executes in about 18% of the time required to execute Univac F1 (about 5.6 times faster).

COBOL program C1 was designed to test file manipulation speed. The Univac C1 executes in about 55% of the time required to execute Xerox C1 (about 1.8 times faster). (But see also Sections 4.8.2 and 4.8.3!)

4.6 LANGUAGE TESTS

The language tests were devised to examine various features of proposed compilers. Some throughput data was also developed by these programs.

4.6.1 BASIC Tests

These tests were done in the timesharing mode. Programs B1 through B7 test many compiler features (for details see Appendix G). Both systems were adequate in performance of all tests.

Actual elapsed time for running these programs is probably more a consequence of the users typing ability than system performance; for that reason timing comparisons are not made.

4.6.2 FORTRAN Tests

These tests were done in the batch mode and timing comparisons are significant. Programs F2, F4, and F5 were satisfactorily executed by both Univac and Xerox. F3, which calculates Fourier coefficients using Romberg integration was not run to completion by Univac. F6, a severe test of the statistical processing capability of a system, was not run at all by Univac. (L. Botten was informed verbally that there had been insufficient time to run F6.)

Timing for these programs is then:

Execution Time (seconds)

Program	Univac 70/46	Xerox Sigma 6
F2	27.2	36.0
F3	----	7.8
F4	30.7	6.6
F5	29.3	7.8
F6	----	117.0

4.6.3 COBOL Tests

These tests were done in the batch mode and timing comparisons are significant. All COBOL programs were satisfactorily executed by both Univac and Xerox. Programs used are actual production programs used at Andrews University.

Timing for these programs is as follows:

Execution Time (seconds)

Program	Univac 70/46	Xerox Sigma 6
C2	49.3	23.4
C3	39.6	12.0
C4	15.4	3.0
C5	7.9	7.2

4.6.4 Conclusions

Both Univac and Xerox BASIC should be entirely satisfactory.

Program F2 had been originally designed to run on the Stanford University IBM 360/67 (a machine considerably larger and more expensive than has been under consideration for Andrews University). The only conversion required for Xerox F2 was to replace control cards. Even more suprising, F2 ran about half as fast on the Xerox Sigma 6 as on the IBM 360/67. In order to relate Xerox Sigma 6 performance to the currently installed IBM 360/22 the following facts may be noted. The Xerox F2 was compiled and executed in 45 seconds. Since F2 cannot be run on the IBM 360/22 as submitted to vendors, a simplified version was prepared. Although the simplified version omitted certain calculations and omitted five of the seven data sets run by Xerox, the program required 69 seconds to execute on the IBM 360/22. Ignoring any effects of simplified calculations but assuming each data set would require 34.5 seconds to execute, the Xerox Sigma 6 time of 45 seconds may be compared (very conservatively!) to an IBM 360/22 time of 241 seconds (about 27 times faster). Xerox F2 (the full version) used 132K bytes of memory (about six times the total user space available with the IBM 360/22).

Program Univac F3 was, unfortunately, manually aborted before completion. Inspection of output indicates that the program was 80% complete in the 12 minutes it was allowed to run. Extrapolating, the program could be assumed to run a total of about 14 to 15 minutes. This compares with approximately one minute required by Xerox F3.

Results of running F4 should be viewed with some caution since it appears as if some data may have been omitted in running Xerox F4.

It is interesting to note that F6 was submitted as a production job in mid-August 1972. Repeated attempts have been made to run this job using IBM Scientific Subroutines and a locally produced package designed to run on the Univac 1108. No run had been completed satisfactorily until Xerox F6 was run. For comparison purposes the following summary is made:

System	Time	Results
Notre Dame IBM 370/155	20 minutes	Incomplete
Whirlpool IBM 370/165	20 minutes	Incomplete
Whirlpool Univac 1108	12 minutes	Invalid
Xerox Sigma 6	2 minutes	Excellent

It should further be noted that standard software packages were used for the IBM 370 and Xerox Sigma 6 runs. As of this report date, the only satisfactory execution was made on the Xerox Sigma 6 (and that on the very first try!).

Xerox FORTRAN seems to be clearly superior to Univac FORTRAN.

Apparently coding changes were not required for either Univac or Xerox COBOL execution. Xerox file definitions differ from presently implemented COBOL, while Univac COBOL is virtually identical. The Xerox COBOL permits the programmer to use default options for file definitions, thus saving coding in some cases. Xerox COBOL does not permit updating sequential disk files, although subroutines are available to do so (several programs in the present systems do this sort of operation).

Both Univac and Xerox performed the COBOL tests in a satisfactory manner.

4.7 MULTIPROGRAMMING AND CONCURRENT PROCESSING TESTS

It was not expected that any vendor would be able to complete all provisions of this test. Both Univac and Xerox completed the minimum required portions of the test in order for valid conclusions to be reached. A series of FORTRAN programs was to be compiled and executed in one job stream and a series of COBOL programs was to be executed in another job stream. The times necessary to complete a full run for each job stream is defined as FORTRAN sequence time (FST) and COBOL sequence time (CST) respectively. The sequences were to be run with no timesharing users to clearly demonstrate at least a minimal multiprogramming capability. The sequences were then to be run with five specified timesharing tasks to demonstrate at least a minimal concurrent processing capability. It was hoped that larger numbers of prescribed timesharing tasks could then be added in order to measure batch degradation as timesharing demands increase. Neither vendor completed this part of the benchmark; however, the required information was obtained from reference account calls.

4.7.1 Timing

Although Univac results are specified to only the nearest minute, the results are still of valid interest (Univac FST omitted F3):

Elapsed Time (minutes)

Test	Univac 70/46	Xerox Sigma 6
Multiprogramming without concurrent:		
CST	2.0	----
FST	4.0	----

Test	Univac 70/46	Xerox Sigma 6
Multiprogramming and concurrent (no T/S):		
CST	3.0	4.1
FST	5.0 (ommitted F3)	7.1
Multiprogramming and concurrent (5 T/S):		
CST	5.5	4.4
FST	7.0 (omitted F3)	8.5

4.7.2 Conclusions

The Univac FST omitted F3. Based on Section 4.6.4 it is clear that Univac FST execution times must be increased by at least 12 minutes (very conservatively) and in fact that Univac FST with five timesharing users should be expected to degrade more than the corresponding Univac CST.

The table of Section 4.7.1 can then be revised on a very conservative basis as follows:

Test	Univac 70/46	Xerox Sigma 6
Multiprogramming and concurrent (no T/S)		
CST	3.0	4.1
FST (estimated)	17.0^{+}	7.1
Multiprogramming and concurrent (5 T/S):		
CST	5.5	4.4

Test	Univac 70/46	Xerox Sigma 6
FST (estimated)	19.0++	8.5

Univac ran each job stream in a multiprogramming mode to demonstrate minimum processing times. By merely allowing the possibility of concurrent processing (even if no timesharing users are signed on), the Univac operating system (VMOS) overhead increases CST and FST! Upon investigation, it was found that the Xerox operating system (UTS) automatically senses the absence of timesharing users and optimizes batch job performance; hence, the multiprogramming without concurrent processing option does not apply to Xerox.

With no timesharing users the Univac system has greater COBOL throughput; however, even five timesharing users reverses the situation. Xerox FORTRAN appears to execute considerably faster than Univac FORTRAN. These facts agree with information obtained by other means. The Univac 70/46 proposed is a maximum configuration. Reference account information indicates that for 10 to 12 concurrent timesharing users response time is several seconds, and for 32 concurrent users response time is several minutes with a batch job stream throughput slowing by a factor of approximately three. With 40 concurrent timesharing users of Xerox Sigma 6 the response time should still be only several seconds and batch job streams should show little degradation. Furthermore, the Xerox system can be considerably enhanced, as required, without changing CPU and without requiring any software conversion. For example, a system similar to to that proposed for Andrews University except for addition of main memory and a larger swapping device has been demonstrated to support 69 concurrent timesharing users with less than 0.5 second response time!

The Univac 70/46 performance is clearly less than adequate in this area.

4.8 CONCLUSIONS

4.8.1 Conversion

Programs from several sources were easily converted for use on Univac and Xerox systems. This indicates the large existing base of programs existing for use on IBM, and other, equipment will be largely useful on either system.

4.8.2 Dedicated Machine Performance Tests

Specific differences in execution speeds for various programs are summarized in Section 4.5. By combining execution times for all programs executed by both systems, some measure of mean execution rates may be derived:

Total Execution Time (seconds)

	Univac 70/46	Xerox Sigma 6
BASIC (B8)	183.7	40.5
FORTRAN (F1, F2, F5)	137.5	58.3
COBOL (C1, C2, C3, C4, C5)	171.5	154.1
Total	492.7	253.9

For the above mix, not necessarily representative of the computing mix at Andrews University, the Xerox Sigma 6 executes all programs in 51% of the time required for Univac 70/46 execution (about 1.9 times faster). Although execution times for C1 by Univac (60.0 seconds) and by Xerox (108.5 seconds) as discussed in Section 4.5.2 might leave the impression that Univac COBOL executes almost twice as fast as Xerox COBOL, that conclusion is not supported by the total execution time for COBOL programs representative of production programs at Andrews University. Programs C2, C3, C4, and C5 were chosen from among existing production programs. In the aggregate, the Sigma 6 executed those programs in 45.6 seconds versus Univac 70/46 execution in 112.2 seconds (2.5 times faster).

4.8.3 Language Tests

Both systems performed the BASIC tests adequately. The Xerox Sigma 6 system performed the FORTRAN test in an outstanding manner. Both systems performed the COBOL tests in a satisfactory manner.

4.8.4 Multiprogramming and Concurrent Processing Tests

Both systems demonstrated a capability for concurrent processing and multiprogramming. Although neither Univac nor Xerox completed tests with more than five concurrent timesharing users, some extrapolation may be made from data provided. Since system throughput degradation is non-linear (more nearly exponential) as more timesharing users are added, a linear extrapolation biases results in favor of the vendor. The linear extrapolation is risky; however, since results agree qualitatively with conclusions formed on the basis of reference account calls, such projection will be made. The Selection Committee submits the projections, as plotted on Figure 1 (page 4-17), as an aid to visualization of results rather than as an analytical tool.

Based on the estimated for Univac FST the following extrapolations may be made:

For:

X = number of timesharing users
FST = FORTRAN sequence time (see Section 4.7)
CST = COBOL sequence time (see Section 4.7)

Then:

Univac FST(X) = 0.40X + 17.0

$$\text{Xerox FST}(X) = 0.28X + 7.1$$

$$\text{Univac CST}(X) = 0.50X + 3.0$$

$$\text{Xerox CST}(X) = 0.06X + 4.1$$

These extrapolations are plotted in Figure 1 (page 4-17).

By inspection of Figure 1 it is clear that for no timesharing users the Univac COBOL had the edge. But for three or more timesharing users the Xerox COBOL performance is dramatically better. The Xerox FORTRAN can be expected to be dramatically better, regardless of the number of timesharing users. The above analysis, and information from reference accounts (described in Section 4.7.2), both indicate that the Xerox Sigma 6 becomes more advantageous the greater the number of concurrent timesharing users. In view of the findings of Section 5, it appears very likely that capabilities of the proposed Univac 70/46 would be exceeded within the first year or two of operation. It should be noted that the proposed Univac 70/46 has the maximum allowed main memory. For these reasons the Univac 70/46 is found to be less than satisfactory.

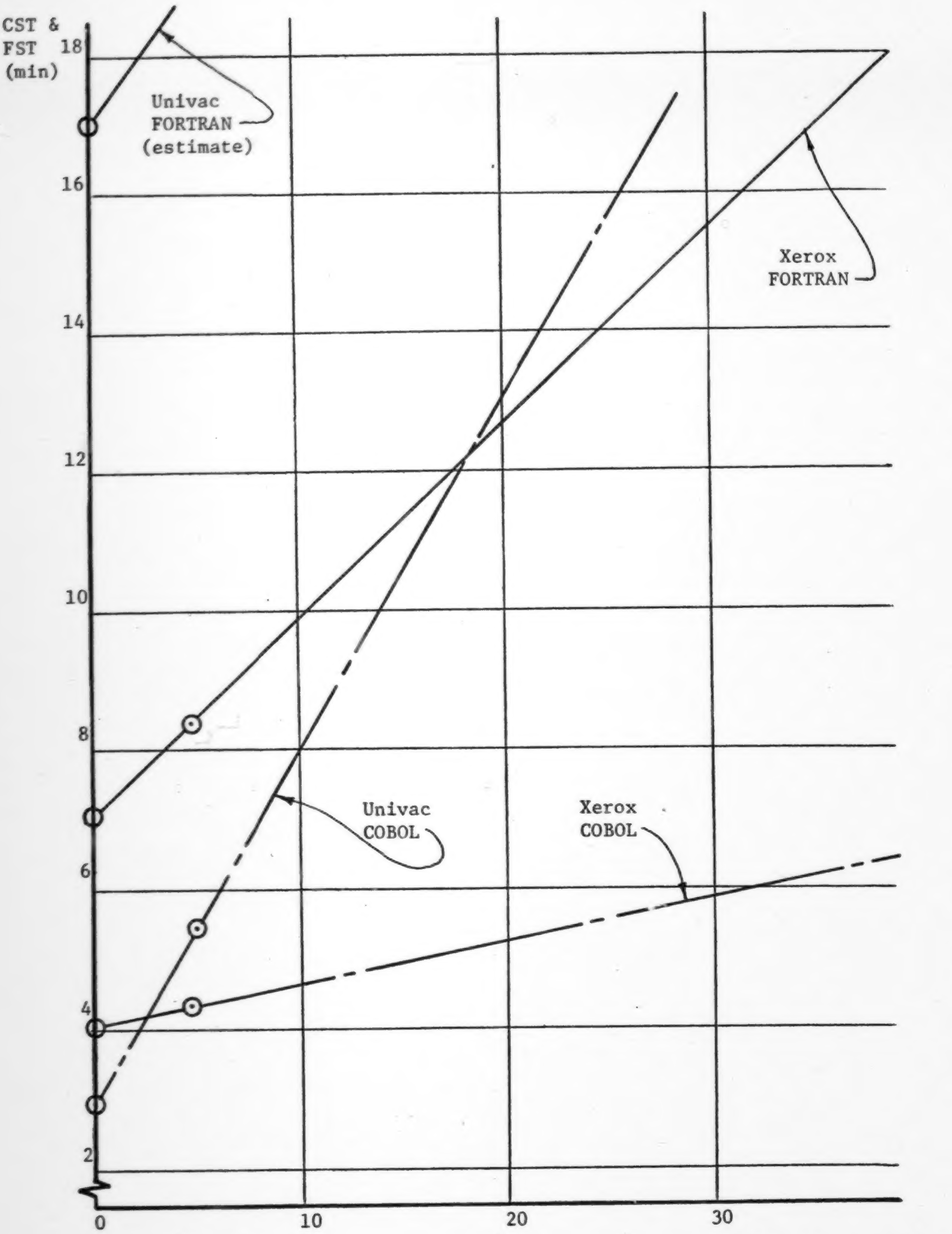
CST &
FST
(min)
18
16
14
12
10
8
6
4
2
0
10
20
30
Univac FORTRAN (estimate)
Xerox FORTRAN
Univac COBOL
Xerox COBOL
Number of concurrent timesharing users

Figure 1

Section 5

TERMINALS AND COMMUNICATIONS

5.1 INTRODUCTION

The market for computer terminals is highly competitive at this time. Developing technology continues to modify the types and cost of available terminals. Although the recommended system may interface with many types of remote devices, it is necessary to ensure that terminals and other communications devices are fully compatible with the system. For these reasons, the detailed study of terminal procurement has been deferred until after the system decision is made. A further recommendation, based on the rapid changes in the terminal market, is to lease, rather than purchase, terminals with advanced capabilities.

It is also recommended that procurement of terminals be made as the terminals are needed and can be individually justified. Such a delay will prove to be an advantage to Andrews University in the existing competitive market.

5.2 TERMINALS

The selection committee has completed an initial review of terminal requirements. The expected growth in terminal requirements is shown in Appendix J. The following minimum initial terminal installation is recommended to support timesharing services:

Location	Quantity	Type
Mathematics Department	2	APL
Physics Department	1	ASCI
Physics Department	1	APL
Chemistry Department	1	TTY
Biology Department	1	TTY
Science Complex (General use)	1	CRT
Science Complex (General use)	1	"2741"
Science Complex (General use)	1	TTY
Business Administration Department	1	TTY
Education Department	1	TTY
Home Economics/Nursing Department	1	TTY
Physical Education Department	1	TTY
Computing Center (Programming)	2	ASCI
Computing Center (General use)	1	CRT
Computing Center (General use)	1	"2741"
Computing Center (General use)	1	TTY
Replacement for MCST's	2	"2741"
Security Office	1	TTY

Key: APL - APL keyboard; probably Teletype Model 38

ASCI - ASCISCOPE video terminal

CRT - video terminal with printer and cassette unit

TTY - Teletype Model 33

"2741" - "Selectric" type terminal for use with EDIT software and APL

The committee recommends that, in addition to the above terminals, the following equipment also be procured for the initial installation:

Quantity	Description
1	Portable printing terminal
1	Digital plotter
1	Optical page reader

It is recommended that the present study be extended to ensure optimum procurement of the above equipment.

5.3 COMMUNICATIONS

The recommended system may be easily expanded to permit computer-to-computer communications (bisynchronous communications; HASP handler) and servicing of polled networks. Although the cost of such expansion is nominal (undiscounted purchase $9,600; maintenance $45 per month), the Selection Committee recommends such expansion be deferred until the need is clearly justified.

Section 6

FINANCIAL CONSIDERATIONS

6.1 OUTRIGHT PURCHASE

Although this method appears to be the least expensive, the cost of capital may be ignored only if Andrews University should have a large available cash surplus. Furthermore, purchasing with borrowed money and repaying with inflated dollars may have substantial benefits. In any case, it does not appear feasible for Andrews University to make the capital investment necessary to obtain a satisfactory computing system. Section 6.5 contains estimates of costs of borrowing the necessary money (thus affecting available credit) and taking direct ownership of the recommended equipment.

6.2 THIRD PARTY LEASEBACK

This method of financing consists of purchasing the equipment (in order to take advantage of all educational discounts), reselling the equipment to a third party (who supplies the capital), and leasing the equipment from the third party. The third party anticipates profits from two sources: from tax relief not available to a non-profit educational institution; and from interest payments, and possibly, retention of residual value.

6.2.1 Advantages of Leaseback Over Outright Purchase

The major purpose of leasing is to obtain the use of capital equipment without having to make capital expenditures. Lease payments can provide a cash flow superior to that of purchase over the early years of the equipment's life. Leasing is an effective hedge against inflation; however, to be fair, depreciation deductions can suffer a negative effect from inflation.

6.2.2 Advantages of Leaseback Over Traditional Financing

Leasing may actually give a cheaper rate. This is particularly true when lessee cannot take advantage of tax benefits such as depreciation and investment tax credit--the lessor can purchase the equipment, claim the tax benefits, and pass the savings on. Leasing spares the use of existing lines of credit and allows full use of borrowing capacity. Most leases provide 100% financing--not even a deposit or down payment dips into capital. Often even acquisition costs (delivery cost, etc.) can be spread over the lease payments.

6.3 VENDOR LEASE

The vendor lease offers many of the advantages of third-party lease methods; although, almost invariably, at higher costs. The major advantages of vendor lease agreements are the capability to easily arrange for upgrade without having to dispose of existing equipment, and the capability to easily arrange for replacement of particular pieces of equipment which may be only marginally serviceable. The last advantage may be particularly important in case of mechanical equipment subject to rapid wear (eg., card punches, printer, or card readers).

6.4 INSTALLMENT PURCHASE

Xerox Data Systems offers an installment purchase plan at 6% simple interest on the unpaid balance with no down payment required. The buyer, of course, retains the residual value of the machine. These liberal terms are predicated on the fact that XDS is not subject to having the machines returned on short notice; hence, the buyer does lose some flexibility. (It appears to be possible to negotiate certain upgrade provisions.)

6.5 OPTIONS

In order to obtain the most powerful computing system at minimum monthly cost, it is recommended that the XDS installment purchase plan be used.

It would be prudent, however, to consider lease of card reader, card punch, and printer for various reasons. As pointed out previously these pieces of equipment are subject to mechanical wear. These devices, as potential sources of reliability problems, are also the subjects of continuing research. There is reason to believe that in the not distant future certain technological breakthroughs will be announced. If these devices are leased it will be an easy matter to replace these units.

6.6 COST ANALYSIS OF OPTIONAL METHODS OF FINANCING

In the following paragraphs the net cost of procurement, exclusive of maintenance, is analyzed for outright purchase, third party lease back, vendor lease, installment purchase, and the recommended mixture of vendor lease and installment purchase. (The cost of straight third party lease is not considered. A leasing company cannot take advantage of sizable educational discounts; therefore, the straight lease plan involves a much higher cost to Andrews University than the third party leaseback plan analyzed.)

In order to simplify analysis the maintenance cost is considered to be constant. Since maintenance is not paid on equipment leased from a vendor, the actual lease rate has been reduced by the amount of maintenance on the vendor leased equipment, thus yielding a net procurement cost.

6.6.1 Outright Purchase

It is assumed that Andrews University could acquire money for the purchase of the equipment from established lines of credit at 7% simple interest on the unpaid balance, and repay the loan over a seven year period.

Purchase Price	$484,060
7% - 7 year factor	.01509
	$7,304.47/month
	$87,653.58/year
Total	$613,575.08

6.6.2 Third Party Leaseback

The least expensive plan for third party leaseback was the one proposed by Funding Systems Leasing Corporation. That plan is summarized below.

Purchase Price	$484,060
10.5% - 7 year factor	.01708
	$8,267.75/month
	$99,212.94/year
Total	$694,490.55

6.6.3 Vendor Lease

Since Xerox does not publish seven year lease rates, the six year lease rate was used in the following analysis.

Monthly	$15,205.50
less maintenance	3,013.60
	$12,191.90/month
	$146,302.80/year
TOTAL	$1,024,119.60

6.6.4 Xerox Installment Purchase

The seven year educational installment purchase rate is equivalent to a loan with no down payment and 6% simple interest on the unpaid balance. The analysis reveals that this plan represents an additional, and sizable, discount.

Purchase Price	$484,060
6% - 7 year factor	.0146
	$7,067.28/month
	$84,807.31/year
TOTAL	$593,651.18

6.6.5 Recommended Mixture of Vendor Lease and Installment Purchase

The following summary is based on lease of the card reader, card punch, and printer. The remaining components of the system are considered to be under an installment purchase agreement. The reasons for this recommendation are given in Section 6.5.

6.6.6. Mixture of Xerox Lease and Installment Purchase

First Year Costs

Monthly Lease Cost(1)	$1,836.00
less adjustment for maintenance	363.35
	$1,472.65
Installment Payments (2)	5,995.05
Total	$7,467.70/mo.
First Year Total	$89,612.40

Annual Cost After First Year

Installment Purchase Price	$73,440
less conversion credits(3)	8,812.8
net purchase price	$64,627.80
6% - 6 year factor	.0166
	$1,072.81/month
6% - 7 year installment payment	5,995.05/month
	$7,067.86/month
	$84,814.32/year

Total Cost

First year	$89,612.40
Years 2-7	508,885.92
Total seven year cost	$598,498.32

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(1) Based on leasing listed peripherals for first year
(2) Based on 6% - 7 year rate for rest of system
(3) Assuming all lease purchase options are exercised

6.6.7 Summary and Conclusions

The first three lines of the table below summarize values derived in previous sections (all values have been rounded to the nearest dollar). The last three lines show differential costs of each plan with respect to the lowest cost financing plan: installment purchase of the entire system. The two entries in the "Mixture" column (in parenthesis) represent first year costs only--after the first year the costs are almost exactly those shown under the "I.P." column.

	Purchase	Lease-back	Vendor lease	Inst. purch	Mixture
Monthly cost	7,304	8,267	12,192	7,067	(7,468)
Annual cost	87,653	99,213	146,303	84,807	(89,612)
Total cost	613,575	694,491	1,024,119	593,651	598,498
Diff. monthly cost	237	1,200	5,125	-----	401
Diff. annual cost	2,846	14,406	61,496	-----	4,805
Diff. total cost	19,924	100,840	430,468	-----	4,847

By inspection of the above table one sees immediately that the least costly method of purchase is the installment purchase. The recommended method of acquiring the system costs an additional $4,847; however, Andrews University does receive the benefit of having a year to evaluate the leased mechanical equipment before commitment to purchase as well as the probability of benefiting from new developments.

6.7 CONVERSION AND INSTALLATION PREPARATION

6.7.1 Conversion

It is recommended that the conversion problem be solved by a joint effort of the Computing Center staff and the Applications Services Department of Xerox. The Xerox group would be responsible for clean compile of all programs and complete conversion and testing of approximately 75% of all existing programs (all of the critical programs).

The Computing Center staff would be responsible for furnishing test data and resultant output to Xerox. (In most cases test data consists of current files.)

The Xerox services would be performed under a fixed price contract. Total proposed fee for the services has recently been reduced to $1,300. As part of the contract negotiations, a complete and detailed conversion plan would be jointly developed.

6.7.2 Installation Preparation

There are two major aspects of preparing for the installation of new equipment. The first task is to prepare the physical facilities, the second task is to procure required tapes, disk packs, storage racks, etc.

A preliminary review of power and air conditioning requirements, and machine room layout, indicates no major alteration of the physical plant should be required. A competitive source of supply for tapes and disk packs is being researched by the Computing Center staff. It appears as if some trade-in credit exists for owned items which are no longer required. Although careful preparations must be made for the installation of a new system, it appears as if such preparation will be relatively easy and inexpensive.

6.7.3 Staffing

A review of Computing Center staff requirements for conversion in consultation with Xerox, is attached as Appendix I. Both full-time staff members would be required in order to develop test data for all programs, to review results of Xerox tests, to complete conversion and testing of those programs assigned to Andrews University, to carry on with maintenance of production programs, and to attend formal training in preparation for use of the new equipment.

The recommendation to add one member to the Computing Center staff is discussed in Section 8. In reviewing the prerequisites for an orderly and efficient conversion and installation it has become apparent that the staff addition should be made as soon as possible so that the new staff member may:

a. Be available for pre-installation training.

b. Participate in system generation (a valuable training experience).

c. Assist academic users in conversion problems.

d. Be available to assist in conversion of existing programs and systems as required.

e. Assist in preparation of a user's guide for the new system.

In participating in these activities the new staff member would help assure a smooth conversion and installation, would be more adequately trained to maintain the operating system upon system installation, and would help promote immediate productive usage of the new system.

6.8 BUDGET CONSIDERATIONS

The proposed 1973-1974 computing center budget (Appendix K) was based on the recommended Xerox Sigma 6 configuration purchased under the seven year Xerox installment purchase plan ($10,081 per month including maintenance). Total equipment and amortization budget requested was $137,616. Total budget request was $260,953. The recommendation to lease rather than purchase the card reader, card punch, and printer adds a total of $4,805 to the first year system cost. Thus, if the Selection Committee recommendation is accepted, the proposed 1973-1974 computing center budget must be amended to $265,758. This represents an increase of $49,982 (23.16%) over the 1972-1973 budget. Of this increase, $8,243 (3.82%) is due to increased staffing and $41,739 (19.34%) is due to increased equipment costs.

The table below compares costs of the presently installed IBM 360/22 to various cost options for the recommended system:

	Comparison Costs		Recommended System	
	IBM 360/22	Inst. Purch.	(1st yr)	(later)
Monthly Computer System Cost(1)	$5,002(2)	$10,081	$10,482	$10,081
Unit Record Equipment	1,286	1,286	1 286	1,286
Total Equipment Cost	$6,288	$11,367	$11,768	$11,367
Outside Services Cost(3)	2,200	zero	zero	zero
Average Total Cost of Services	$8,488	$11,367	$11,768	$11,367
MCST Cost Savings	zero	-350	-350	-350
Net Average Cost of Services	$8,488	$11,017	$11,418	$11,017

Note that no credit is taken for recovered costs except for the two magnetic card selectric typewriters (MCST's) which may be immediately replaced by the recommended system. The net increase in cost in going from the IBM 360/22 to the recommended system is nominally $2,500. It is expected that part of this increase may be recovered by sales of services to other institutions.

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(1) Including maintenance.
(2) Includes savings inherent in leasing disk drives from ITEL ($814 per month) and $500 per month amortization on owned printer.
(3) Estimated; based on typical month during Fall Quarter.

Section 7

TERMS AND CONDITIONS

7.1 INTRODUCTION

Copies of standard Xerox leasing, installment purchase, and maintenance contracts are included as Appendix H. In order to ensure adequate protection of the interests of Andrews University it is recommended that a competent commercial attorney be retained to inspect the standard contracts for potential sources of difficulty. It is also recommended that the attorney inspect final contracts before execution.

7.2 NON-STANDARD CONTRACTURAL ARRANGEMENTS

Every attempt should be made in contract negotiations to obtain the following non-standard protections:

- Stationing of a customer engineer and storage of essential spares at Andrews University (even if we must provide office and storage space).
- Specification of new style memory.
- Guarantee of upgrade and trade-in privilege for components under installment purchase plan for at least the first eighteen months after installation.
- Guarantee of provision for maintenance of all system

components for the entire life of the installment purchase contract with escalation protection.

- Non-appropriation clause.
- Provision for system and software acceptance tests.
- Conversion and installation non-performance penalties.
- Guarantee of adequate system analyst support for entire life of the installment purchase contract.
- Guarantee of adequate documentation at fixed cost.
- Guarantee of adequate training assistance at fixed cost.
- Right to pay off balance without penalty.
- Right to transfer equipment to any affiliate of General Conference of Seventh-day Adventists without jeopardizing maintenance or systems analyst support.
- Right to use independent memory or peripheral equipment which does not require modification of Xerox equipment.
- Contract termination clause allowing Andrews University to terminate contract should Xerox bow out of the computer business.
- Bundling guarantee for entire life of the installment purchase contract.

Section 8

RECOMMENDATIONS

> Computer buffs . . . have been likened to small boys who, given a hammer, suddenly find that everything needs pounding.
>
> —Readings in Psychology Today

8.1 INTRODUCTION

Although many members of the Selection Committee can be described as computer buffs, a serious effort was made to be conservative in assessing the computing needs of Andrews University (see Appendix C). Based on these needs a set of minimum system criteria and specifications was defined (see Section 2.5).

8.2 FINDINGS

In response to questions before the Selection Committee (see Sections 2.2 and 2.3), the following findings are submitted:

- Cost factors indicate that total university needs can best be served by one computer system serving both academic and administrative users.

- Academic and administrative computing requirements include support of versatile timesharing, support of concurrent timesharing and batch processing, support of batch multiprogramming, support of input-output spooling, and capability to process 100,000 character batch programs.
- The cost of an adequately configured IBM 370/135 is prohibitively high regardless of financing method.
- The cost of commercial timesharing services is significantly higher than similar services provided by an on-site computer system.
- The Selection Committee was asked to evaluate several plans involving the expansion of the presently installed IBM 360/22. Even with the maximum possible system expansion of the IBM 360/22, resultant systems fail to provide adequate batch or timesharing capabilities.
- Present Computing Center staffing is not adequate to meet academic needs.
- The Xerox Sigma 6 computer system, as described in Appendix L, best meets the needs of Andrews University on the basis of demonstrable system hardware and software capability, vendor software support, vendor maintenance support, vendor conversion support, system growth options, financial arrangements, and total cost.

8.3 RECOMMENDATIONS

The Selection Committee submits the following recommendations:

- Xerox should be designated as the vendor to supply computing equipment and related services required by Andrews University.
- Negotiations should be initiated with Xerox representatives to finalize the following:
    a. An installment purchase contract to purchase the proposed Sigma 6 computer system (less printer and unit record devices) for delivery prior to June 15, 1973. The anticipated cost (based on six percent simple interest on the unpaid balance) is $5,995 per month.

    b. A lease of the unit record and printer subsystems (card reader, card punch, and printer). The anticipated cost is $1,836 per month.

    c. A maintenance contract for purchased equipment. The anticipated cost is $2,650 per month.

    d. A conversion services contract. Anticipated total cost is $1,300.

    e. Installation, conversion, and training schedules.
- In order to answer specific needs of Andrews University certain non-standard contractural arrangements should be negotiated with Xerox (see Section 7).
- Standard Xerox contracts for lease, installment purchase,

and maintenance should be evaluated by a commercial lawyer for potential sources of difficulty. Final contracts should be reviewed by a commercial lawyer prior to acceptance.

- The contractural arrangements made with Xerox should bear the name of General Conference Corporation of Seventh-day Adventists rather than Andrews University Corporation. If this is not feasible, a non-standard agreement should be made with Xerox to permit transfer of the system to any other denominational affiliate at our discretion.
- A study of optimum methods of procuring terminals (as outlined in Section 5), a plotter, and an optical page reader should be conducted as a supplement to the computer selection study. This study should also isolate requirements for disk packs, tapes, and storage facilities and optimum methods for procurement.
- A study of required physical plant modifications should be instituted as a supplement to the computer selection study. At this time it appears as if no structural modifications will be necessary.
- Steps should be taken promptly to hire a qualified academic consultant.
- All Magnetic Card Selectric Typewriter systems on campus should be replaced by 2741-like terminals as soon after system installation as practicable.

8.4 XEROX SIGMA 6

8.4.1 Advantages

The Xerox Sigma 6, announced in May 1970, offers extremely versatile operational capabilities and fast internal computational speed. IBM 360 compatibility was established as a design criterion, and Sigma 6 employs the same external and internal data codes and formats as IBM 360 systems. (Thus, the conversion of widely available IBM 360 software can be easily accomplished.) Hardware and software support permits efficient and flexible data communications processing capabilities. Xerox is responsive to servicing installed computers and offers a wide range of academic and business applications software. A new line of printers using the Xerographic process is under development, and such printers could significantly increase print quality while decreasing cost. A variety of high level languages may be implemented on the Sigma 6 in either batch or timesharing mode. The timesharing capability and data base management capability of the system are especially noteworthy.

8.4.2 Disadvantages

The only known sources of potential difficulty are possible maintenance problems for certain peripherals (card reader, and card punch) and a minimal possibility that Xerox might leave the computer business.

The maintenance problem can almost certainly be overcome by requiring

Xerox to provide a locally based maintenance man. As further insurance, and to allow an opportunity to observe new developments in the printer field, it is recommended that the card reader, card punch, and printer be leased for the first year. The more capable card readers and card punches offered by Xerox are known to be quite reliable. If maintenance problems should prove to be insurmountable for the units initially installed, a change could be made prior to making a purchase agreement. The Selection Committee does not consider this to be a serious problem.

In May 1969, Xerox acquired Scientific Data Systems (SDS). SDS had had considerable difficulty in meeting certain software delivery commitments. Xerox completely reorganized the software development organization of SDS and, in less than three years, has developed a sophisticated data base management system and a wide variety of other business oriented software (the scientific users of SDS equipment had been well satisfied).(1)

On March 7, 1972, Xerox announced the formation of a new Information Systems Group responsible for marketing, distributing, and servicing both its copier and computer product lines.

While Xerox's copier business has been consistently very profitable. the company's computer business has yet to show a profit. The formation of the Information Systems Group demonstrates Xerox's strong commitment to electronic data processing (EDP) and dispels rumors that Xerox might follow RCA and bow out of the EDP industry.

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(1) This paragraph, and the next three paragraphs in this section, were extracted from the 1972 Auerbach Computer Technology Reports on the Sigma Series. Auerbach is noted for thorough and unbiased evaluations.

The Wall Street Journal for January 18, 1973, contained significant comments on expected improvements in the Xerox computer revenue position (the entire article is included as Appendix M):

(Excerpt and Appendix M intentionally omitted.)

A detailed financial evaluation of the Xerox Corporation was made by A. Klein. A copy of Mr. Klein's report is included as Appendix F. Based on that study there is no expectation of difficulty in regard to Xerox

Corporate stability.

In considering the above information, the Selection Committee believes the risk of Xerox leaving the computer business to be minimal.

8.4.3 Growth

Many types of remote terminals and communications devices may be interfaced to the Sigma 6. The system may be expanded to capabilities well beyond what should be required by Andrews University during the next seven years. Such expansion requires installation of main memory and disk storage units. The central processing unit need not be changed; hence, no conversion or reprogramming would be required.

The recommended system is very capable. However, it is expected that as timesharing and on-line administrative applications increase, some system expansion will be required. System enhancement may be accomplished with considerable flexibility and at relatively small incremental cost. For example, adding 64,000 bytes of main storage (about three times the user memory area of the presently installed IBM 360/22--much of the 360/22 memory is used by the operating system) would cost $19,400. A similar addition of 25,000,000 bytes of disk storage (a little more than is presently installed with the 360/22 would cost $14,280. For further details of pricing for various growth options refer to Appendix L.

The Selection Committee submits that growth may be easily adjusted to the needs of Andrews University and should present little difficulty if enhancements are based on projected cost-benefits. It is recommended that such trial projections be made annually. Only when enhancements are clearly justified, should they be made.

8.5 STAFFING

The key to effective usage of computing equipment is adequate staffing. To properly support increased academic computing and to ensure adequate operating systems maintenance, an additional qualified full-time staff member is required. (Additional comments on staffing related to conversion are contained in Section 6.7.3.)

It is recommended that, as annual trial cost-benefits projections are made with regard to equipment, similar consideration be given to staffing requirements. For example, where applications which could represent a net savings to Andrews University are delayed by lack of applications programming staff, it could well be a sound financial decision to increase the programming staff. As for equipment, such changes should be made only where clearly justified.

8.6 REVIEW STUDY

In addition to the annual studies described in Sections 8.4.3 and 8.5 it is recommended that a thorough review of computing needs and adequacy of services be made in the summer of 1977 (or earlier if required).

Such a study should ensure that Andrews University computing capabilities are neither deficient nor excessive.

APPENDIX A

Appendix A

Excerpts From

"COMPUTERS IN HIGHER EDUCATION"(1)

I. INTRODUCTION, FINDINGS, AND RECOMMENDATIONS

After growing wildly for years, the field of computing now appears to be approaching its infancy.

In the field of scholarship and education, there is hardly an area that is not now using digital computing. Computing is a new resource in learning. It enables the student or the scholar to deal with realistic problems rather than oversimplified models. By lessening the time spent in the drudgery of problem solving and in the analysis of data, it frees time for thought and insight. Partly, it enables the student to do old things more easily, but more important, it enables him to do things he otherwise could not. Computing increases the quality and scope of education.

The widespread use of computing in scholarship as well as industry and government has come about not just because of a general enthusiasm for computers, but because this new tool has found vital and increasing use in each field in which it has been applied.

If we are to exploit our opportunity fully, students in colleges and universities must see for themselves what a powerful tool computing is, and learn to use it. No matter what his specialty, the student must be given the opportunity of using computers in learning and in doing, and the faculty member must be able to use computers in teaching. Both the individual's opportunities and the progress, well-being, and stature of our society can be increased by adequate computing facilities for our colleges and universities.

The recommendations we make are expensive, but if they are not carried out there will be a different kind of cost. Today, the best and richest institutions are able to carry part of the burden of educational computing. As time goes on, these institutions will improve the service they give their undergraduates, while smaller and poorer institutions will be trying to catch up. . . . If the deficit in educational computing is not made up quickly, millions of students who will have attended these institutions in the 1970's will be poorly prepared for the world of the 1980's and 1990's.

The major findings and recommendations of the Panel are:

1. Approximately 35 percent of college undergraduates are enrolled in curricula in which they could make valuable use of computers in a substantial fraction of their courses. An additional 40 percent are in curricula for which introductory computing training would be very useful, and limited computer use would be part of several courses. The remaining 25 percent could make some use of computers in one or more courses during their college education, but computer training is not now important in their major studies.
2. One of the major problems in providing the necessary educational computing is the cost.
3. We find that any expansion of the educational use of computing

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(1) Pierce, John R., Chairman. "Computers in Higher Education; Report of the President's Science Advisory Committee", U. S. Government Printing Office, 1967.

depends heavily on increased knowledge of computing by faculty in most disciplines. Such knowledge usually can be provided by intensive 2-to-6 week periods of faculty education.

4. There is a great need for specialists trained in the computer sciences at the bachelor's, master's, and doctorate level.

5. The cost of computing is a continuing expense, like light or water, rather than a capital investment, like the initial cost of buildings.

6. The optimum mechanism for providing computers will differ from campus to campus. However, in many cases it appears economical and effective to supply adequate and dependable service from large computing centers.

7. Because of inconsistent Government and university accounting practices, the great variety of sources of computing support, and the experimental nature of computer use, some universities have had difficulty in determining and controlling their computer costs. Informed decisions regarding expansion and/or budgeting for current operations cannot be made without accurate cost information. Errors made at this stage can only lead to the diversion and dissipation of university resources needed for other educational purposes.

8. Proper introduction of computing into secondary education is desirable and growing.

II. COMPUTERS AND UNDERGRADUATE EDUCATION

Computers were first introduced into universities as rare and special pieces of equipment used for a few specialized sorts of research by small groups of people. Today, many universities and colleges have centers which serve most of the students, faculty, and administration both by providing training in programming and by meeting computing needs for undergraduate education, for research, and often for administration.

Where adequate computing facilities have been available, the faculty has made increasing use of computing in both research and education, and computing has become a part of more and more undergraduate courses, including business subjects, social sciences, biological and health sciences, psychology, geology and other disciplines, as well as mathematics, physics, chemistry, and engineering. This is consistent with the rapidly growing use of computing outside the schools in small as well as large business enterprises, in government operations and national defense facilities, and in almost all technology--those many fields of endeavor where most college graduates will find their places. Computing is not an esoteric or specialized activity; it is a versatile tool useful in any work with a factual or intellectual content. Computing is becoming almost as much a part of our working life as doing arithmetic or driving a car.

Computers find a widespread use in education only when well-run facilities are easily available to all students and faculty members, with rapid service for all users. Under these conditions there are a number of instances (including, for example, Dartmouth and Texas A. & M.) in which a majority of all undergraduates learn programming and use computing in some part of their course work. While computing has not yet become an important part of undergraduate course work in such fields as English, linguistics, languages, history, music, and art, faculty members in some of these fields are making increasing use of computers in research, and computing is beginning to find its way into undergraduate instruction.

In all fields where computing has been used, it has added a new dimension to education, and has led the students to better comprehension of complex problems and greater insight into the meaning of quantitative expressions. In these areas undergraduates have learned, through preparation of and experimentation with computer programs, of the care required to define a problem logically and fully, and the assumptions needed to obtain answers to complex problems. We predict that in the future almost all undergraduates will use computers profitably if adequate computing facilities are available. There may be a few students in some fields who will not use computers at all, but they will be a small minority.

Using a Computer is Easy

It is possible to make effective use of computers without programing training. "Computer aided instruction" systems and some information retrieval system (Medlars, for instance) are examples of uses which do not require appreciable programing knowledge. There are many other examples for which the user need only supply data to existing programs.

However, acquiring some knowledge of programing is easy, and it greatly extends the scope of the educational use of computers. This is particularly true when special student-oriented programing languages are used. Ten to thirty hours spent in learning programing enable a student to use computers profitably in course work. This contrasts stikingly with the time needed to acquire a useful knowledge of mathematics or of a foreign language; it is more comparable to the time spent in learning to drive a car. It is the universal experience of all those with whom we have talked that students spontaneously made use of computers in solving problems or handling data even when this was not intended. A further evidence that learning to program is easy is that in many places programing training is extending down into secondary education.

The Nature of Educational Computer Use

The earliest educational use of computers provided instruction in programing followed by student use in solving assigned course-work problems adapted to computer colution.

Continued familiarity with the computer allows students to use it in courses in which no such use is specifically required--reducing data obtained in laboratory courses, or making statistical evaluations in sociology courses, for instance. Familiarity of faculty as well as students with computing leads to the assignment of computer-oriented special problems, and even to undergraduate student research projects which could not be carried out without computing. Such student work is valuable education and highly desirable.

It is of the utmost importance to keep in mind that computing should not be thought of primarily as a new subject to be taught in addition to all the other important material now in the curriculum. Teachers who make use of computers in a wide variety of subjects have found that their material can be taught more rapidly, more thoroughly, and more meaningfully with the aid of computers.

We Have Second Class Education for the Majority

Adequate computing is not available today in many fine small colleges. Further, even in many larger colleges or universities which have reasonably powerful computers, the computers are not accessible to the majority of undergraduates, wither through lack of an appreciation of the usefulness of computing on the part of the faculty, or lack of suitable instruction, or lack of suitable computer languages, or through the way in which facilities are administered or financed. Yet these institutions train undergraduates of excellent ability. Many of these graduates will go out into the business world where they will need to understand and use computers.

Many others of these undergraduates will go on to a wide variety of graduate work unequipped with a simple but vital skill in problem solving and unaware of its power and versatility. The handicap of a lack of understanding and skill in the use of computers is extremely severe in all areas in which data analysis is vital, in learning as well as in practice--in business, in the social sciences, in psychology, in geology, in the health sciences, for example. In a very real sense, students who have not learned to use computers are badly equipped for the postbaccalaureate world.

We believe that undergraduate college education without adequate computing is deficient education, just as undergraduate education without adequate library facilities would be deficient education. At present, deficiency in computing is widespread. We believe it to be vital to the national interest as well as to the welfare of the individual student to remedy this deficiency quickly.

What Is Adequate Service?

. . . Several things are essential even to the most modest user if the aim is education rather than hard knocks:

Adequate instruction in and consultation concerning computing . . .
Adequate software . . .
Reliable operation . . .
A fast turn-around time . . .
Interactive remote consoles . . .
Graphic output . . .
Visual displays . . .
New forms of input . . .

Who Should Use Computers?

By sometine in the 1970's it is doubtful that more than a few percent of the students will graduate without having made some use of computers. A rough guess of the portion of the undergraduate enrollment in each of these categories as of about 1972 is tabulated in Section A and suggests that approximately 35 percent will make substantial use, 40 percent will make limited use, and 25 percent will make casual use.

Problems of Paying for Computing Service

. . . Our colleges and universities clearly have a central responsibility to pioneer in and to adopt new educational techniques and methods. What is so special, then, about the use of computers in education?

The answer lies in the extremely rapid growth rates in computer-related costs which are being experienced by many universities (and should be experienced by more of them). Universities and colleges, whether public or private, are all faced with rising costs and a precarious balance between income and outgo; the public institutions are overwhelmed by the tidal wave of student enrollment, whereas the private institutions are struggling to provide improved student services and to keep pace with the rising faculty salaries in an enterprise dependent upon relatively fixed income sources.

Many of our institutions of higher learning have already responded to the significance of computers for all aspects of their programs by establishing new departments of computer sciences. Such a step is a major one for any university, involving new long-range commitments to faculty tenure and to providing building space. Yet, in addition to these very substantial financial loads, the universities also face the very high cost of hardware and manpower to generate and use software. And these total costs are mounting at incredible annual growth rates--figures as high as 45 percent per year are given in the Rosser report--which are an order of magnitude larger than the budgetary growths universities are used to providing from their own funds, with great effort, to academic divisions.

Estimation of Cost of Adequate Computing for Undergraduate Education

Universities get computing at bargain rates compared with industry. . . . Reasonably skilled student help is available at as low as $1.25 an hour, and salaries for professional help appear to be lower than in industry. Educational discounts have reduced machine costs. Certainly, those who pay for campus computing get it at a bargain rate.

Problems of Providing Facilities

Large computing centers can provide high quality remote service while using a batch--processing type of operation. . . . However, present experience tends to show that immediate access to computers through interactive remote consoles will be practical and desirable, rather than a luxury. It is a conclusion, rather than a recommendation, that a large part of the necessary computing service will be provided by systems of this sort.

III. THE COMPUTER SCIENCE STUDENT

. . . This work calls for access to and interaction with a good computer center. Since many computer science departments also grant a master's degree, it is difficult to separate the undergraduate use from use at the master's level. Graduate work in computer science calls for substantial use of computer time in carrying our research on software and toward new computer applications.

The demand for people trained in computer sciences exceeds the supply.

Despite the importance of instruction in computer sciences, the total amount of computing connected with such instruction will certainly be small compared with the total amount of undergraduate educational computing which we have estimated earlier in this report because there are so many fewer computer science students than there are college undergraduates. Thus, if the deficit in undergraduate computing is made up, as we propose, an adequate amount of computing would be available for computer science education. It is of course important that such use be recognized as a part of the education use of computing.

We must not, however, overlook the quality of computer facilities necessary for good education in computer sciences. . . . Though computer science education and research need place only modest demands on a large computing center, the quality of the center is of utmost importance.

IV. INTERACTION BETWEEN RESEARCH AND EDUCATIONAL USES OF COMPUTERS

It seems very desirable to favor large, up-to-date university centers which can serve a variety of needs, including research and administration as well as education. This is particularly desirable in that the educational load may be more seasonal than the research load, so that a system serving educational needs alone might be nearly idle in the summer. Though the funding of research and administrative computing costs may well be different from the funding of educational costs, it is only reasonable to ask that educational needs as well as research needs be taken into account in establishing and operating large computing centers.

There is another way in which research computing may seriously affect the educational use of computers. We believe that unless computers used in research are managed wisely and effectively, money which might be used to advantage in education may be wasted.

We have observed that most colleges and universities have no adequate provisions in their budgets for educational computing.

. . . Unless adequate provisions are made for the support of research computing, the very resources which are needed for educational computing, and indeed, for the rest of education, may be drained away by unforeseen research needs. . . . It is particularly important that universities do not carelessly allow overruns in research computing to penalize the education of their students.

V. THE COMPUTER AND SECONDARY EDUCATION

Training in the use of computing and in the nature of computers and computing is rapidly but randomly invading secondary education. We have felt it impossible to approach the problem of computers and secondary education quantitatively both because of the sheer magnitude of the problem and because of the lack of quantitative information. However, through personal experience and the testimony of others we have formed some preliminary opinions concerning the problems involved.

The advantages of introducing the use of computing into course work and of teaching something about the nature of computers and computing in secondary schools can be considerable, either as a preparation for college work, as a preparation for semiprofessional or vocational training, or as a preparation for employment. Such training in secondary schools will increase rather than decrease the amount of educational computing required in colleges and universities.

There can, however, be real disadvantages to an unwise introduction of computer training in high schools. Detailed and narrow training in commercial programing languages and the operation of commercial computers has apparently led some able young people to accept dead end jobs in a market hungry for people with computer know-how, when they might better have gone on to college and fitted themselves for more productive and rewarding places in our economy.

Vocational training in computers and computing has a legitimate place in terminal secondary education, but this may not be the chief contribution which computing has to make to secondary education. Secondary-school students should be taught what computers and computing are. In addition, it may be that computers can be used to improve the teaching of many courses. Computers may be useful in stimulating the interest of students who cannot be reached in other ways.

Computing is best used in secondary schools by means of convenient facilities, such as remote consoles, and simple instructional programing languages. Instruction in the nature of computers and computing can be by means of special texts supplemented with specially designed experimental equipment.(1)

Unfortunately, this approach is contrary to much that is now being done in secondary education. Sometimes the computer used is one which is used for administrative purposes, which may be ill adapted to proper introductory instruction. Sometimes the computer used is a small machine purchased or rented primarily for instruction, but awkward to use and of limited computing power compared with a remote console attached to a large modern machine--or even compared to job shop operation by courier or mail on some accessible more powerful machine.

This is not to deny that good and useful secondary-school instruction can be carried out with less than optimal facilities. But we believe that money is often spent, and financial obligations incurred (through the purchase of computers which will be expensive to replace when they become obsolescent and expensive to maintain at all times) which could be better applied in securing service from a more suitable source. Indeed, many secondary schools may, for want of guidance, reexperience all the difficulties that universities and colleges have already gone through in coping with computers and computing.

Cooperation between secondary schools and universities, and particularly providing service to secondary schools from university centers, should be encouraged.

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(1) Such as the material in the text, "The Man Made World," and the associated experiments being prepared by the Engineering Concepts Curriculum project under the auspices of the Commission on Engineering Education.

A. COMPUTERS IN HIGHER EDUCATION

Introduction

In attempting to assess the educational need for computers in colleges and universities, we find ourselves compelled to believe that within a decade essentially all university and college students will require some basic understanding of digital computation.

In short, we believe that the computer and computing are rapidly coming to have an impact on the life of practically every member of our society. Most people educated beyond the high school level will have occasion to make use of these tools, and all will need sufficient understanding of their possibilities and limitations realistically to appraise the new opportunities now available for information processing.

In all parts of education, government, or industry, digital computer use has come about because it is an effective tool. Each new use leads to several more--like bookkeeping, inventory control, airlines reservations, on-line control of manufacturing processes, design of structures, diagnosis of disease, market analysis and forecasting, design and analysis of experiments in the social and natural sciences. It is a new tool with unusual implications.

Suddenly, it seems, the computer and its many applications has opened a new technical field to woman. Of all technological fields the computer area shows the greatest growth in the employment of women, largely those with baccalaureate degrees in mathematics.

In every day life the computer problem looms equally large. Automation is the usual name for the problem. It means using computers to control machines and processes previously carried out by human labor. A threat perhaps, but equally an opportunity. Many people can be relieved from jobs of mental or physical drudgery. With additional training they can carry out more complex jobs using computers than their abilities allowed before. How many checkout clerks in supermarkets could add well enough to hold their jobs without a computer--the cash register?

Clearly some acquaintance with digital computers will be as essential to the next generation as is now familiarity with the automobile and the radio. It will need to know what a computer is, its uses and limitations. For college and university students the time required to get such familiarity may be about that to learn to drive a car. Unfortunately, parents can't teach about computers so the colleges and universities must.

An Estimate of Needs

A quantitative estimate was made by classifying the needs of major areas of study as (1) substantial, (2) limited, and (3) casual. Category 1 includes primarily all the biological and physical sciences and engineering and roughly half the social sciences, mathematics, and business and commerce. Category 2 contains the other half of mathematics, social science, and business plus three-quarters of education. Category 3 includes mostly the humanities.

In category 1 an introductory course in the freshman year would allow students to make routine use of the computer in many courses--probably more than 50 percent--throughout their undergraduate career. Students in category 2 will probably take an introductory programing course at an early stage of their education and then make some use of the computer in three or four other courses during their 4 years as an undergraduate. Students in category 3 need not make any use of the computer as part of their major study although it is quite likely that even they will find it useful in a few courses. By sometime in the 1970's it is doubtful that more than a few percent of the students will graduate without having made some use of computers.

A common characteristic of both the general and professional education in computers is that the student is gaining understanding of and facility with a tool. Such instruction is often best given, in terms of motivation and of skill, in connection with the study of the discipline for which the tool is important. Thus we would expect that students of education might learn digital computation in connection with analysis of educational statistics. Introductory physics students might find digital computation a powerful tool for reduction of experimental data or in simulation of experiments.

Institutions will differ in the way in which they introduce students to digital data processing, and this is healthy. But if the most is to be made of limited time--and every new subject introduced into the college curriculum now faces rigorous competition from other subjects which can make excellent claims on the student's time--it is important that computers be used to extend rather than displace the student's grasp of other subject matter.

In undergraduate education the computer offers especially exciting possibilities in teaching the formation of hypotheses or theories. Physics, for example, has been very successful in describing and explaining the physical world because theories could be constructed and results calculated on the basis of fundamental principles. Yet it still is sometimes hard to separate the logical from the empirical content of our knowledge of physics.

As Prof. W. M. Huggins of Johns Hopkins University has pointed out, computer methods now permit us much more readily to examine the logical consequences of a given set of assumptions in nearly any discipline without turning to analogous systems in the real world which imperfectly realize the assumptions. In these situations, the implications of theory may be examined with a "pure" system in which a prescribed sequence of operations can be performed precisely as specified without any uncertainties or irrelevancies from the real world contaminating the investigation.

This manmade world of the computer will enable all disciplines to a greater or less degree to generate an idea, hypothesis, or theory, and test its value completely independent of its practical realization. Added to this possibility is the computer's ability to handle data with all the complexity that exists in the real world. Such powers have never existed so extensively before and have tremendous potential at all levels of the educational process.

An Important Plus

We have discussed the need for and cost of education in the use of computers as a tool in solving problems in various disciplines. This seems to us the most direct route to knowledgeable use of computers by students and faculty. But the presence of a computer, or its input-output terminals, on a campus creates an additional opportunity with equally great rewards.

These rewards could come in the form of assistance in the teaching-learning process itself. Many exciting new experiments have the student interacting directly with the computer through typewriter, visual, or audio presentations. With competent and careful programing of the computer one finds it helping the student to construct answers rather than picking them from a list; to learn as he would from a teacher.

The potential to the student and increased effectiveness of the teachers merit intensive development of computer assistance learning at all educational levels. With large computers, more faculty experienced in their use, and better input-output devices, this teaching process can be explored and developed toward the end of the period we are considering. It is possible that productivity gains will provide much better education at very reasonable costs.

Classification of Computing Needs by Major Areas of Study

Major Area of Study	Usage		
	Substantial	Limited	Casual
Agriculture			4,600
Architecture		600	
Biology	23,000		
Business and Commerce	28,000	28,000	
Education		84,000	28,000
Engineering	33,000		
English and Journalism			35,000
Fine and Applied arts			16,000
Foreign Language and literature			12,000
Forestry		1,300	
Geography		1,200	
Health	1,000	10,500	
Home Economics			5,000
Library science	500		
Mathematics	9,500	9,000	
Military	2,500		
Philosophy			4,700
Physical Sciences	17,500		
Psychology	7,000	6,500	
Religion			3,600
Social Sciences	38,000	38,000	
Others			12,000
Total (460,000)	160,000	179,000	120,900
100 (Percent)	35	40	25

B. SOME FACTS OF LIFE ABOUT COMPUTERS

The mode of using computers has changed steadily through the years. In the earliest days of computers, each user took his program individually to the machine and used the computer either until his problem was solved, or until he ran out of assigned time. This is no longer feasible except in the use of obsolete computers which have been replaced but not discarded, and when one considers maintenance and space for such machines, it is of dubious merit.

One of the first advances in adapting computers to easy use was the open shop together with batch processing. Open shop operation means that anyone who follows specified rules can get a program run, not just a selected group of programers. By batch processing we mean that the programs and data for a lot of jobs which various people want done are put on a magnetic tape and run through the computer in sequence. This means that all programs to be run must conform to certain rules, and use the input and output facilities which are provided for all. All these functions are implemented by a small amount of additional hardware and a large executive or system program to manage the operation automatically.(1) Batch processing can cut down the turnaround time, the time between handing a job in at a computer center and getting an answer back, to one or two hours. As computers have come to be used by more and more people for a greater variety of jobs, even this may be too long to wait for an answer.

A recent development which makes computers more efficient and more flexible in use is called multiprograming. The flexibility is obtained by having the computer take up tasks in order of their ease or brevity. This is similar to a garage mechanic's having a 5-hour job but taking on easier 5-or-10 minute jobs as they come in. By interrupting the larger job periodically, more customers are satisfied and no one must wait for a very long time. In multiprograming the computer can leave a long job partly done to take on other, shorter ones, then return. This procedure also leads to greater efficiency. Without multiprogramming, the entire expensive computer system can be idle if processing is delayed for any reason; for example, if a new input tape must be mounted during the course of computation. This wastes both time and money . . . With multiprograming, another job, or part of a job, can be started (or even completed) during these necessary interruptions.

Another recent improvement in computer organization permits many users to have access to the machine simultaneously. This is called multiple access.

Both multiprograming and multiple access permit increased efficiency of computing facilities and produce better service for more users.

The interaction between man and machine is an essential element in many modern uses of computers. The computer types out a text, or draws a picture, or places packages for minimum wire length, or calculates the deflections in a mechanical structure, and a man observes the result and makes alterations to correct defects or to improve performance. Multiprograming, multiaccess, and peripheral computers and visual displays are important elements in making such interactions between man and machine quick, easy, and efficient.

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(1) Programs of this kind become an integral part of the computer to users, and so are often called "software" as a contrast with the hardware. The other computer operating schemes mentioned in the remainder of this appendix are also implemented by a hardware-software system, not by hardware alone.

C. COMPUTER LANGUAGES

The provision of appropriate, adequate, and efficient languages is one of the vital ingrediants in the wider and more effective use of computers. This is a strong reason in favor of providing students and faculty with access to a large and powerful computer, rather than a small computer of limited flexibility and capability.

D. EDUCATING THE FACULTY IN USE OF THE COMPUTER

The greatest initial effort to aid faculty members would probably be for disciplines which are already making substantial use of the computer. Engineering comes to mind immediately as an outstanding example. Statistics is another good example of an important computer application; it touches many areas of the social sciences, biological sciences, and physical sciences. It is probably that many faculty members may have their first occasion to consider use of the computer in connection with statistical problems.

Younger faculty, who are closer to their graduate student days, may have greater awareness of the growing importance of the computer, and they may, therefore, be among the first to bring pressure on the computation center staff to learn about the computer. But it has been pointed out that a relatively short interval of intense training can prepare a faculty member to make effective use of the computer, and it is clear that many faculty members from all age groups will--and should--want to become conversant with the computer.

Need to solve a particular set of problems or to keep current in one's field provides an important motivation for a faculty member to seek instruction in use of the computer. . . . Another motivation for the faculty member is his desire to keep pace with his students who have found the computer fascinating and useful.

It is very important for the faculty to recognize that the time needed to cross a significant threshold of understanding so that one may begin to do useful work for oneself and his students is very low compared to a discipline such as mathematics or operations research or languages.

There is evidence, from experience at schools such as Dartmouth, that a nearby console and simple programing languages, if available, make it especially easy for a faculty member to learn and to experiment with the new tool in spare moments and in private.

E. THE LARGE UNIVERSITY COMPUTATIONAL FACILITY

The Patterns of the Past

In the past, computation has usually come to colleges and universities through a proliferation of computers around the campus, each computer assuming a single role such as teaching, research, or university administrative data processing. While this "solves" the problem of administering computers, albeit in a costly and redundant manner, it generally begs the question of how the computation might best serve the needs of education, and it establishes artificial boundaries which tend to stifle the healthy growth of university computer use.

The Place of the Computer in the University

The advent of time sharing, terminals of many types, and the modular computer makes computation more flexible and powerful, but it makes the administration of computation more difficult. In the past a computer has often been administered by some special group which uses it the most, has the money to support it, has the space to house it, or sometimes merely has had the courage and energy needed to obtain the device. While all of these reasons were probably valid at the time the computer was obtained, the passage of time and changing conditions will almost certainly invalidate the original reason for control of the computational facility by a single department or specialized group.

A proper global view by its management enables the computation facility to react to the combined needs of the whole university rather than just the particular needs of a single department or group.

The ultimate administration of the facility should rest in the hands of an administrator so placed as to be cognizant of the total needs of the university. Due to the leadtime necessary to obtain additional or replacement computational equipment, the administrator of the computational facility must be aware of the long-and-short range plans of the university in order to have time to react to planned changes.

It is essential that the management of the facility have sufficient independence so as not to be dominated by any one division of the university and that there be enough intellectual leadership in the center so that it can understand the educational goals of the administration and be competent to work with the faculty and students. Caution should be exercised to make certain that all users have a forum in which their needs and dissatisfactions can be heard. When communication ceases, the usefulness of the facility decreases. This is particularly vital in the field of computer sciences. The computer sciences faculty should not be burdened with the administration of a computer center. Nor should their research and teaching interfere with the continuous and effective operation of the center in providing service. However, computer science people should have a stong voice in the introduction of new hardware and software and in adapting computers to new uses.

Facility Orientation

The chief reason for existence of a computation facility is to provide computation, whether for teaching, or research ranging from history to computer sciences.

In view of the large dollar value associated with computer devices and staffs, it would seem reasonable that all campus computational facilities should be coordinated through one person having the responsibility for the total computational and data processing needs of the campus.

Since the universities are training the men of the future, it seems obvious that the men should be trained on the most modern equipment available today in order to have a fair chance in the world of tomorrow.

Facility Operation

In order that the facility provide adequate quality service, it must be user directed. While one computer can work in practically all areas of problem solving, it is rather doubtful that one person can work in all areas. This situation requires that problem-oriented people serve as an interface between the user and the computer. Many of these problem-oriented people will be administratively outside of the facility; some may be within it. The number of interface people will vary widely with the number of user areas served by the facility and the extent of experience and capability of the interface personnel.

In general, the staff of the facility will fall into four categories: (1) administrative, (2) operational, (3) software oriented, (4) user oriented.

The administrative personnel should concern themselves with the long-and-short-range plans of the facility while continually coordinating the efforts of the other three groups.

The operational personnel should be concerned with the daily operation of the facility and should attempt to maximize through-put and minimize turnaround time.

The software-oriented personnel should concern themselves with the operating systems of the facility, ever conscious of the needs of both the user and the operations staff. The availability of good software is probably more important than good hardware. It is not necessary or desirable for most schools to write large operating systems programs since they will be available from other sources. However, it is important that software oriented personnel be available to interpret, modify, update, and add to these programs.

The user-oriented personnel are the outward face of the computer facility. They should serve as the buffer and interpreter between the user and the facility. A failure in the first line of defense can well make the rest of the facility ineffectual.

The Machine

An unfortunately common first step into the computing field is the acquisition of one or more small machines with complete open-shop operation. While this type operation is rewarding to the user, it is somewhat difficult to justify on a cost basis, and the user soon becomes disillusioned by the limited size and speed of the machine.

When the terminal is mentioned, one normally visualizes a typewriter-like device with someone operating the keyboard at a poor typing rate. The term terminal should be taken to mean any input-output device available. One can visualize not only typewriterlike terminals in using areas, but also high-speed readers and printers, graphical display devices, and and small peripheral computers which store data and process it to some extent but call on the central computer for difficult processing and computation. Such terminals, and problem-oriented languages and compilers open a whole vista of possibilities for university computation utilizing a central processor and time sharing.

F. WHAT COMPUTER FACILITIES ARE APPROPRIATE

Smaller COlleges

Actual experience has shown that a single teletypewriter can expose computing to hundreds of students during the course of an academic year. Naturally, a deeper involvement in computers with more frequent exercises will require additional teletypewriters.

Secondary Schools

In general, the purpose of secondary-school education in the use of computation should be to enable the student to understand the nature, ease and power of computation, and to use ti in course work in a veriety of subjects. This is best done through the use of simplified languages which are not available on small computers.

G. ESTIMATION OF REQUIRED COMPUTER CAPACITY AND COST

Introdcution

Estimating the required computer capacity and its cost is difficult because of the complex interrelationship of the needs, the variety of available facilities, and the uncertainty in the possible rate of growth. . . . On the basis of available data and experience we believe that the simple programing languages, convenient terminals, and rapid access of time-sharing systems will lead to a faster growth rate and a more widespread use than with older batch-processing systems. For example, at Dartmouth, within 2 years after installing a time-sharing system, usage grew from essentially zero to the point where more than one-half of the students used the computer each quarter. Further time-sharing systems appear to be an economical means of providing high quality computing service to almost all schools.

Estimation of Needed Capacity

The basic unit in the calculation was chosen to be the average number of hours each student is at a console in each week. This figure was estimated as one-half hour per student per week. (Very roughly, this would be equivalent to one-half minute of processing per week on a large batch-processing computer.) It was obtained by estimating that those students making substantial use of the computer would total 130 hours at a console during their 4 years, those making limited use would total 46 hours, and those making casual use would total 18 hours. The average use during a 4-year curriculum, based on the estimated classification according to major areas of study, is then 0.35 (130)+0.4(46)+0.25(18)=69 hours. This is 17.25 hours per year of about one-half hour per week of the school year. The total hours of use in each category might be made up as follows:

Substantial	Hours	Limited	Hours	Casual	Hours
Introductory course.........	10	Introductory course.....	10		
10 other courses, 12 problems per course.....	120	4 other courses, 6 problems per course..	36	3 courses 3 problems per course..	18
Total..........	130	Total.......	46	Total.......	18

Cost of the Consoles

. . . A reasonable estimate of their cost is $125/month. Since most students are in schools needing at least 10 consoles, it is assumed that about 25 percent excess is adequate.

J. EXAMPLES OF THE USE OF COMPUTING IN COURSE WORK

Business

Instructor's comments: The computer does analysis computations that would take over 100 hours on a desk calculator. Without it, the analysis would be simplified to eliminate many important aspects; with it, more time can be spent on the interpretation and meaning of the analysis.

Instructor's comments: The computer enables students to explore the process with 10-12 cases, each with 10-12 time periods. It takes the exercise out of the realm of arithmetic and makes it a real learning experience in the management of a process.

Mathematics

. . . "It's so fantastic it's almost impossible to say how much better the course is. The amount of practice the students get is up by one to two orders of magnitude."

Data

Before a computer was made available to the students a problem of this sort could not be assigned because the calculations would have required too large a portion of their study time. Now they are able to do several such problems which provide a good base for considering more complex and realistic systems later. The students have reacted very enthusiastically to its introduction into the course.

. . . The realistic problem made possible by the computer relates the material covered in the mathematical treatment of numerical methods to a "real" engineering problem and gives students confidence in their ability to solve real problems.

Ralph Lazarus
Federated Department Stores, Inc., Cincinnati, Ohio

The digital computer has already proved to be of great value in recording, controlling, and analyzing the masses of merchandise information which we require to run our increasingly complex business. It is also used more and more effectively in our analysis of current operationa and seasonal budgeting.

It will become even more valuable as we learn to use its qualitative potentials for longer range knowledge, and decisions which we have to make. We should be using this tool to identify not only future needs of consumers, but also in what kind of environment and with what kind of services they will wish to make their purchases.

As we develop our organization for the future, we will be searching for men and women not only knowledgeable in the principles of management, but in the techniques of applying these principles as well. We will be looking to the universities to produce graduates with a broad spectrum of knowledge, including an understanding of the use of computers to manage a large business, both short and long range.

Daniel V. DeSimone
Director, Office of Invention and Innovation, U. S. Department of
Commerce, National Bureau of Standards

It is common to say that the computer has changes our lives, that it enables us not only to do things better, but to perform tasks never before feasible to man. What is not common is the realization that the computer has given man a new freedom, which is of enormous significance to the education and fulfillment of this generation and all those to come. It has released him from the drudgery of the past and given him new opportunities to utilize his creative powers, as the Greeks put it in another age, along lines of maximum excellence.

It is of the greatest importance, therefore, that man be educated to harness this electronic servant, for only then will he more universally be free to develop and fulfill himself creatively. And we would hope, too, that with this new freedom, our educational system will then devote greater emphasis on stimulating the inventice and innovative potential of students, for it is not sufficient merely to teach them what the computer can do for them. They must also be taught what the computer cannot do for them.

John G. Kemeny
Dartmouth College

. . . I am of the opinion that no other academic program yields as high as dividend, per time invested, as the freshman computer program. Even if the student never again touches the computer, he will leave the college with a sensible attitude toward the use of high-speed computers. We also know that a significant minority of the students avail themselves of time-sharing in connection with more advanced courses. The ability to assign computer problems as a matter of routine, in any course that has a year of mathematics as a prerequisite, is beginning to show a significant effect on the campus. Our engineering and business schools have made most imaginative use of time-sharing in a wide variety of courses. We also find scattered, but interesting use throughout the science and social science departments. And everyone seems to agree that the use will expand as the faculty gains more experience. . . .

H. W. Johnstone, Jr.
Professor of Philosophy and Assistant to the Vice President for Research,
Pennsylvania State University

Let me begin by agreeing with you (J. R. Pierce) that most undergraduates should be exposed to computers and computing as tools. But my own argument for such exposure is not that most students ought to learn to use the computer in order to solve practical problems, any more than I would argue that they should study scientific method in order to solve practical problems. Scientific method, in the form in which is sometimes a required course (or part of one) for all or most undergraduates, is a liberal study. Its purpose is to acquaint the student with the nature of scientific thinking, so that he will see science not as a kind of familiar magic that he takes for granted, but rather as a human achievement. In my view, a similar liberal course ought to be given on computers. The emphasis would be upon the concept of a computer and upon the general methods of using computers. The student who had been exposed to such a course would see the computer as a human achievement rather than as a black box to be taken for granted. He would see how the possibility of using computers to solve problems has revolutionized the ways in which we think about the problems. A person for whom the computer is merely something to be used gains from his contact with it no appreciation of the nature of the contemporary world. Such appreciation presupposes a certain awareness of the nature and method of the computer as such--an awareness that is quite different from the knack of programing in FORTRAN. No one could say that the course I have in mind is concerned with gadgetry.

I would say that the nature and method of the computer are philosophical ideas, like those of the nature and method of science in general. Most of the ideas presented in truly liberal courses are philosophical. The philosopher can be concerned with these ideas in a deeper way than is either the student or teacher of the liberal course. The philosopher is not content merely to expound the ideas; he is interested in stating as clearly as possible what they mean. Both the idea of the computer itself and society's assumptions about the use of the computer need analysis and clarification.

The philosopher sees culture as manmade, and indeed as an expression of man's view of his own nature. Medieval culture was the expression of the view that man is at home in the world. When science first arose in the 17th century, it was both the cause and the result of an increasing sense of alienation from the world. Man regarded himself as a creature of subjectivity, whose senses screened him from the invariant mathematical relationships that governed the universe in its infinity. Nowadays we are less sure that these relationships are invariant, less sure that the universe is infinite, and more confident in our own point of view. Some of this confidence has been won through the use of the computer. Its role in our culture is thus an expression of our view of our own nature.

At our symposium (the computer symposium presented at Bell Laboratories in June 1966), I was fascinated by the particular applications that you are making of computers. What impressed me most deeply was that in the number of these applications we have reached a turning point. The use of the computer has all at once spread to all aspects of our culture. It is this that struck me as being of primary philosophical relevance. What is relevant is the way the computer has changed the quality of contemporary life--not so much in satisfying our material needs as in causing us to think about ourselves in a new way.

H. O. Pollak
Director, Mathematics and Statistics Research
Bell Telephone Laboratories

. . . Future computing specialists, future secondary teachers of mathematics, future research mathematicians, future users of mathematics in other disciplines, and future teachers of undergraduate mathematics make up most of our body of mathematics students. It is clear that most undergraduate mathematics courses should contain questions, problems, and pieces of theory which are motivated by the numerical aspect of the subject. Furthermore, all mathematics majors should have an exposure to the computer.

APPENDIX B

(Intentionally Omitted)

APPENDIX C

Appendix C

NEEDS VERSUS DESIRES

In order to establish specifications and criteria for computer selection, it was necessary to determine required and useful features. The determination was based on extensive meetings with faculty members (most departments were consulted) as to needed and desired applications.

Those features found to be required are listed:

- ANSI COBOL and administrative applications packages.
- Versatile timesharing (BASIC or XBASIC; ANSI FORTRAN; ANSI COBOL).
- Load-and-go FORTRAN.
- Concurrent batch and timesharing capability.
- Large batch processing capability (at least 100 K bytes) for at least COBOL and FORTRAN.
- Batch multiprogramming and spooling capability.
- Two or more 9 track tape drives.
- Capable statistical and scientific applications packages.
- Data base management system.
- Text processing system.
- Discrete and continuous simulation packages.
- String Manipulation language.
- CAI language and applications packages.
- Optical page reader.
- Digital plotter
- CPU to CPU communications capability (not necessarily implemented with initial configuration).

Those features found to be vary valuable, although not absolutely required, are listed in order of priority:

- APL.
- Graphics capability.
- Digitizer.
- PERT and Linear Programming application packages.
- FORMAC.

APPENDIX D

(Intentionally Omitted)

APPENDIX E

ANDREWS UNIVERSITY
BERRIEN SPRINGS, MICHIGAN 49104
Telephone: (616) 471-7771

November 22, 1972

To: Richard Hammill

From: LeRoy Botten

Subject: Interim Academic Feasibility Study Status Report

The Academic Feasibility Study Committee has completed the first phase of its work. From an initial group of 22 system proposals, 8 were selected for detailed study. Based on vendor presentations and literature, Data-Pro (and similar sources), and a limited sampling of reference accounts a preliminary analysis has been completed. The analysis assigned points to about 400 categories grouped into the five major areas included in the attached table. The numbers in parentheses represent the weight assigned to the major areas.

The remaining rows in the table are self-explanatory, but should be interpreted with caution. The weighted point total is a measure of system performance; however, we deferred analysis of available applications programs until after this initial screening was completed. The monthly cost represents total cost of the system based on our purchase cost, maintenance cost, software cost (as appropriate), and a depreciation allowance for our printer. A standard pricing formula was used for comparison purposes. Before the study is completed, these costs may be changed based on revised configurations or alternative funding methods. (A standard configuration was used to permit cost comparisons--our initial installation may not require the full evaluation configuration.)

Several vendors have been eliminated on the basis of not meeting required performance criteria: Burroughs 5500, Honeywell 430, IBM 370/125, and NCR 200. We feel closer investigation will help separate the closely grouped remaining systems. In particular, now that the number of systems has been further reduced, we will be able to apply more detailed methods of study. Art Klein is doing a financial analysis on Digital Equipment Corporation, Hewlett-Packard, Xerox Data Systems, and Funding Systems Leasing Corporation. We will contact a larger sampling of reference accounts and plan visits to installations where practicable. We will arrange for proof that certain vital existing programs can be properly compiled and executed. We will be studying in great detail the available applications packages. A new series of vendor presentations on a very technical level will be scheduled.

Two other noteworthy additions have also been made to the study. The first is comparison of our study to that of (intentionally omitted). The second is a detailed consultation with (intentionally omitted) on the results of our study to date.

Although these results are encouraging, they represent only interim results These conclusions depend heavily on what the vendors claim for the systems. This part of the study was planned to ensure that we did not overlook the potential "best possible" system. The next phase of investigation is intended to carefully verify the claims of the manufacturers and ensure that the system finally recommended will perform satisfactorily in our applications. For this reason, the final recommendations of the Academic Feasibility Committee may differ from conclusions drawn from data collected to this point.

INTERIM SUMMARY

	B 5500	DEC 1040	HP 3000	HIS 430	IBM 370	NCR 200	U 70/46	XDS 6
Hardware Capabilities (20)	110	101	103	69	79	62	93	86
Growth Potential (15)	92	126	74	84	88	86	92	122
Operating System (20)	98	114	116	84	80	62	106	110
Languages (20)	112	110	88	67	74	21	65	66
Conversion, Maintenance and Software Support (25)	42	65	96	64	101	93	86	98
Weighted Point Total	442	500	483	363	426	325	441	471
Weighted Rank	4	1	2	7	6	8	5	3
Eliminated by Criterion	X			X	X	X		
Monthy Total Cost (60 months)	8708	8944	7062	7488	8435	8881	9737	9129
Cost Ranking	4	6	1	2	3	5	8	7
Overall Ranking		2	1				4	3

APPENDIX F

Appendix F

CORPORATE STABILITY REPORT

A. Klein of the Business and Administration Department was asked to evaluate the strength and stability of the vendors of the four systems not eliminated on the basis of criteria and Funding Leasing Systems Coporation (a firm offering computer financing via leaseback). Based on Standard and Poor's, and Argus rating systems; and on brokerage contacts the following comments are submitted:

Xerox Data Systems: 10% of gross is in computer field; Argus (scale of 1 to 4) rates Xerox Data Systems as 1; Xerox Corporation is solid, conclusions regarding Xerox Data Systems are less clear.

Univac Division of Sperry Rand Corporation: Univac is the largest contributor to Sperry Rand sales and earnings; Univac is second only to IBM in the computer industry; Univac revenues are expected to increase; Univac is very healthy.

Hewlett-Packard Company: very healthy corporation; only small fraction of business (2% of gross) is in computers; Hewlett-Packard could easily back out of the computer business; Argus (scale of 1 to 4) rates Hewlett-Packard Company as 2.

Digital Equipment Corporation: major strength in the mini-computer market; excellent profit and loss record; Argus (scale of 1 to 4) rates DEC as 3; although DEC is not as large as those firms rated above it is totally committed to the computer field; it is a very strong firm.

Funding Systems Leasing Corporation: a wholly owned subsidiary of Funding Systems Corporation; Equimark Corporation owns 51% of FSC; $47,647,000.00 is invested in FSLC; no evident problems exist.

(Pages F-2 through F-15 intentionally omitted)

APPENDIX G

ANDREWS UNIVERSITY

REQUEST FOR BENCHMARK

Berrien Springs, Michigan December 11, 1972

REQUEST FOR BENCHMARK

Purpose

The principle purpose of this benchmark study is to demonstrate that certain representative programs can be executed, on the systems proposed for installation at Andrews University, by vendors receiving this request. Sample production programs, and appropriate test data, are also included in order to measure ease of conversion. The secondary purpose of the study is to measure compile, execution, and response times of representative programs, under controlled circumstances, as an aid in assessing processing capabilities of the various proposed systems.

Andrews University does not suggest that the programs submitted constitute a comprehensive or representative mix of processing to be accomplished in the future. Rather, the programs were chosen to exercise certain compiler and machine features which are of particular interest.

Time Frame

In order to obtain system delivery at a time acceptable to Andrews University, an order must be placed no later than the middle of January 1973. For that reason we must require that results of this study be in the hands of LeRoy Botten absolutely no later than 1:00 p.m. on January 8, 1973. Please do not request deviations from this policy, none can be granted. If for some reason the study can not be completed, please return partial results. Results received after the stated time can not be considered.

Evaluation of Results

Andrews University reserves the right to make the final determination of the value and usefulness of any or all parts of the study. In view of the commonly understood difficulties of conducting a fair benchmark study, we do not intend to make a final determination necessarily based on the results of the benchmark. Nevertheless, we do desire results which can be used to make meaningful comparisons between proposed systems.

Since a relatively short time has been allowed to complete the study, we do not expect that a test system will be configured precisely to the bid configuration. It is necessary that a full description of the test configuration be forwarded with test results. Results submitted without an adequate configuration summary will not be considered.

One of the most difficult tasks in evaluating a benchmark study is determining how variations between bid and test configurations have biased results. Realizing that each vendor is in the best position to understand any existing biases, we expect that a full disclosure of such biases will accompany test results. The cover letter accompanying test results, or partial test results, must contain the following statement:

> "(Vendor) certifies the configuration proposed for Andrews University will meet or exceed performance standards specified or implied by the attached benchmark test results. Where necessary, due to differences between proposed and test configurations, results of tests have been adjusted to represent the proposed configuration performance. All such adjustments have been specifically noted. (Vendor) is willing to include in the final contract a committment to rerun the benchmark study on the installed system as a final acceptance test such that system acceptance by Andrews University will be contingent on performance equal or better in all respects than performance specified or implied by the enclosed test results."

Please understand the intent of the above paragraph is to help prevent a difficulty common to many benchmarks: test systems that are configured to perform better than proposed systems. Vendor cooperation with the intent of this paragraph should help Andrews University to fairly interpret the results of this benchmark study. Results submitted without the above statement will not be considered.

Programs

The test programs (described in enclosures) will be identified in the test procedures as follows:

BASIC

B1	BATCH REGRESSION
B2	CONVERSATIONAL REGRESSION
B3	RANDOM
B4	MATRIX
B5	FILES
B6	GRAPH
B7	ALPHA
B8	B CRUNCH

COBOL

C1	FILE	
C2	CREATE UPDATE	
C3	PRINT	
C4	COPY	
C5	SORT	
C6	DEMO	(data for C2, CREATE)
C7	DEMO	(data for C2, UPDATE)

FORTRAN

F1	F CRUNCH
F2	DIFFRACTION
F3	FOURIER
F4	EQNS
F5	COMPLEX

Conversion Test

Record man-hours and systems resources required to convert COBOL programs C1, C2, C3, C4, and C5. Provide listings of converted programs.

Dedicated Machine Performance Tests

In order to allow controlled timing tests,the following programs are to be separately run on a totally dedicated system in the timesharing mode: B8, C1, F1. Program logic includes print statements which are to used in timing. Using a stopwatch, time the interval between the "RUN" command and start of the output, "START;" record this interval as "compile time." Using a stopwatch, time the interval between the start of output, "START," and the completion of output, "STOP;" record this interval as "execution time."

Similarly, the following programs are to be separately run on a totally dedicated system in the batch mode: B8, C1, F1. Modify program code as necessary to use system interval timer to record "compile time" and "execution time" as defined in the previous paragraph. Record interval timer precision.

Language Tests

Make coding changes required to execute B1, B2, B3, B4, B5, B6, and B7 in the timesharing mode. Submit a listing of each program as executed and corresponding output.

Make coding changes required to execute C2, C3, C4, and C5. Submit a listing of each program as executed, compile-through-load time for each program, and output from C3. Timing to be based on system interval timer (make coding changes required for its use with each program).

Make coding changes required to execute F2, F3, F4, and F5. Submit a listing of each program as executed, compile-through-load time for each program, and output from each program. Timing to be based on system interval timer (make coding changes required for its use with each program).

Multiprogramming and Concurrent Processing Tests

For the background processing in this test two job streams are to be used: a precompiled COBOL job stream composed of data C6 and C7 processed by precompiled programs C2, C3, and C4; and a sequence of compile-and-go runs for F2, F3, F4, and F5. Each of these job streams is to be run in the order shown. On completion of each sequence the cycle is to be immediately restarted (eg., F2, F3, F4, F5, F2, F3, F4, F5, F2, ...). Using the system interval timer, measure the time from start to end of each sequence (as requested below) and record as "COBOL sequence time (CST)" and "FORTRAN sequence time (FST)" respectively. Submit a listing of each sequence as executed.

No Timesharing Users

Record average values of CST and FST with no timesharing users.

Five Timesharing Users

Record average values of CST and FST with five timesharing users occupied as follows (each user repeats his "assigned" process during duration of test phase):

1	creating and debugging B1
2	running B2
1	creating and debugging C1
1	creating and debugging F5

Ten Timesharing Users

Same as for five timesharing users, except two sets of timesharing users as described above.

Fifteen Timesharing Users

Same as for five timesharing users, except three sets of five timesharing users as described above.

Minimum Standards

Although all parts of the benchmark test are of interest,the time allowed for completion is somewhat less than would normally be expected. Andrews University is most interested in complete results for the Conversion Test, the Language Tests, and at lease some demonstration of multiprogramming and concurrent (timesharing with batch) operation. When these results are assured the other tests should be run.

BASIC PROGRAMS

B1 BATCH REGRESSION

This represents a typical student program in which the student takes about 15 minutes typing in the initial source program and then takes about 10 minutes debugging and testing the program running it several times while making the corrections.

```
10    LET T1=T2=T3=T4=T5=0
20    READ N
30    FØR I=1 TØ N
40    READ Y, X
50    LET T1=T1+X
60    LET T2=T2+Y
70    LET T3=T3+X*X
80    LET T4=T4+Y*Y
90    LET T5=T5+X*Y
100   NEXT I
110   LET V1=T3-T1*T1/N
120   LET V2=T4-T2*T2/N
130   LET V3=T5-T1*T2/N
140   LET B=V3/V1
150   LET A=T2/N-B*T1/N
160   PRINT "Y INTERCEPT A", A
170   PRINT "SLØPE B", B
180   LET R=V3/SQR (V1*V2)
190   PRINT "CØRRELATIØN R", R
200   STØP
210   DATA 5
220   DATA 12, 1
230   DATA 18, 2
240   DATA 26, 3
250   DATA 42, 4
260   DATA 55, 5
270   END
```

B2 CONVERSATIONAL REGRESSION

This represents a typical library program in statistics or a program in computer assisted instruction. The user calls the program that has been stored on line and then uses it for one or two problems. The whole procedure may take 5 minutes of question and answer dialogue.

```
10   PRINT "SIMPLE LINEAR REGRESSIØN"
20   PRINT "NUMBER ØF ØBSERVATIØNS";
30   INPUT N
40   LET T1=T2=T3=T4=T5=0
50   PRINT "TYPE Y, X FØR ØBSERVATIØN"
60   FØR I=1 TØ N
70   PRINT I;
80   INPUT Y, X
90   LET T1=T1+X
100  LET T2=T2+Y
110  LET T3=T3+X*X
120  LET T4=T4+Y*Y
130  LET T5=T5+X*Y
140  NEXT I
150  LET V1=T3-T1*T1/N
160  LET V2=T4-T2*T2/N
170  LET V3=T5-T1*T2/N
180  LET B=V3/V1
190  LET A=T2/N-B*T1/N
200  PRINT "Y INTERCEPT A", A
210  PRINT "SLØPE B", B
220  LET R=V3/SQR (V1*V2)
230  PRINT "CØRRELATIØN", R
240  GØ TØ 20
250  END
RUN
SIMPLE LINEAR REGRESSIØN
NUMBER ØF ØBSERVATIØNS? 5
TYPE Y, X FØR ØBSERVATIØN
1?12, 1
2?18, 2
3?26, 3
4?42, 4
5?55, 5
Y INTERCEPT A   ########
SLØPE B         ########
CØRRELATIØN     ########
NUMBER ØF ØBSERVATIØNS? STØP
PRØGRAM STØPPED.
```

B3 RANDOM

This program demonstrates the random number generator and the RANDØMIZE statement.

```
10   RANDØMIZE
20   FØR I=1 TØ 30
30   PRINT INT (100*RND);
40   NEXT I
50   STØP
60   END
```

B4 MATRIX

The following program demonstrates the MAT commands solving a set of n simultaneous linear equations for n unknowns.

```
10   DIM A (10,10), B (10,1), V (10,10), X (10,1)
20   READ N
30   MAT READ A (N,N),B(N,1)
40   MAT V=INV (A)
50   MAT X=V*B
60   MAT PRINT X
70   STØP
80   DATA 2
90   DATA 1,3
100  DATA 2,1
110  DATA 20,30
120  END
```

B5 FILES

This program illustrates file handling procedures for creating files, reading and writing files, and listing files.

```
NEW:FILE1
10   2,4,3
20   1,1,2
30   2,1,6
40   3,3,2
SAVE
NEW:FILE2
SAVE
NEW:PR0G
10   FILES FILE1; FILE2
20   READ #1;A,B,C
30   IF END #1 THEN 70
40   LET T=A+B+C
50   WRITE #2;A,B,C,T
60   G0 T0 20
70   ST0P
80   END
RUN
0LD:FILE2
LIST
```

B6 GRAPH

This program creates a graph using the TAB function.

```
10    FØR X=6 TØ 50 STEP 2
20    LET T=10*SQR (X)
30    PRINT X;TAB(T);"*"
40    NEXT X
50    STØP
60    END
```

B7 ALPHA

This geography drill creates and uses an alphabetic list.

```
10    DIM A$(100), B$(100)
20    READ N
30    FØR I=1 TØ N
40    READ A$(I),B$(I)
50    NEXT I
60    PRINT "GEØGRAPHY DRILL"
70    PRINT "TYPE THE NAME ØF THE CAPITAL CITY"
80    PRINT "AFTER THE STATE"
90    FØR I=1 TØ N
100   PRINT A$(I);
110   INPUT X$
120   IF X$=B$(I) THEN 140
130   PRINT "CØRRECT ANSWER IS";B$(I)
140   NEXT I
150   STØP
160   DATA 5, ØHIØ, CØLUMBUS, ØREGØN, SALEM, CØLØRADØ, DENVER
170   DATA MARYLAND, ANNAPØLIS, MICHIGAN, LANSING
180   END
```

B8 B CRUNCH

This program is designed to test the looping mechanism and, to some extent, the raw processing power in BASIC.

```
10    PRINT "START"
20    LET T=0
30    FØR I=1 TØ 1000
40    FØR J=1 TØ 1000
50    LET T=T+1
60    NEXT J
70    NEXT I
80    PRINT "STØP",T
90    STØP
100   END
```

FORTRAN PROGRAMS

F1 F CRUNCH

This program is designed to test the looping mechanism and, to some extent, the raw processing power in FORTRAN.

```
      WRITE(6,2)
2     FORMAT(6H START)
      T=0.0
      DO 4 I=1, 1000
      DO 4 J=1, 1000
4     T=T+1.0
      WRITE(6,6) T
6     FORMAT(5H STOP,F15.0)
      STOP
      END
```

F2 DIFFRACTION

This program uses iteration to calculate the Debye-Waller factor for data included in the program. The solution found is for equation (2.111).

The control cards included in the listing are for WATFIV.

The phenomenon of inelastic diffraction is a valuable tool for the study of the lattice dynamics of crystals. The beam diffracted in a particular direction is associated with lattice modes having a definite wave-vector $\mathbf{q}$. One can look at the change of energy of the diffracted particles, and hence measure $\hbar\nu_{\mathbf{q}}$. By looking in different directions, and moving the crystal into different orientations, one can plot out the whole function $\nu_{\mathbf{q}}$. Of course, this has several branches, of different polarization, but these may be separated by systematic analysis.

However, this experiment is only practicable with 'thermal' neutrons, whose wavelength is of the order of the lattice spacing at energies of the order of 0·1 eV. The shift due to the phonon energy, which is of the order of $k\Theta$ or less—perhaps 0·01 eV.—can easily be observed. For electrons and X-rays the beam energy must be much higher—tens or hundreds of electron volts—so that the small change in energy in the diffraction process cannot be detected.

2.9 The Debye–Waller factor

The terms in (2.97), corresponding to scattering processes involving one phonon, are not all that may occur in the structure factor (2.95). It is easy to see that the product of factors like (2.96), and also higher terms in the expansion of the exponential, give rise to contributions containing various products of factors like $\mathbf{U}_{\mathbf{q}} \exp(i\mathbf{q}\cdot\mathbf{l})$. For each such factor, one says that the corresponding phonon has been created or destroyed, so that these terms refer to *multiphonon processes*.

Generally speaking, these processes fall off rapidly in rate as we go to higher order, and do not contribute very heavily to the background of inelastic diffraction. There is, however, an important class of terms, arising from the squared term $-\frac{1}{2}|\mathbf{K}\cdot\mathbf{U}_{\mathbf{q}}|^2$ in the expansion (2.96), which do not average to a small contribution. If we look at (2.95) and (2.96), we find that matrix element for both elastic and inelastic scattering ought to be multiplied by

$$e^{-W} = \prod_{\mathbf{q}} \{1 - \tfrac{1}{2}|\mathbf{K}\cdot\mathbf{U}_{\mathbf{q}}|^2\}. \tag{2.103}$$

This is called the *Debye–Waller factor*. It is written in this form because we can use a standard theorem of algebra

$$\lim_{N\to\infty} \prod_{n=1}^{N} \left(1 - \frac{1}{N}a_n\right) = \exp\left\{-\lim_{N\to\infty} \frac{1}{N} \sum_{n=1}^{N} a_n\right\} \tag{2.104}$$

to transform the product into a sum. Thus

$$e^{-W} = \exp\{-\sum_{\mathbf{q}} \tfrac{1}{2} |\mathbf{K}\cdot\mathbf{U}_{\mathbf{q}}|^2\}, \tag{2.105}$$

i.e.

$$W = \tfrac{1}{2}\sum_{\mathbf{q}} |\mathbf{K}\cdot\mathbf{U}_{\mathbf{q}}|^2. \tag{2.106}$$

To evaluate this sum, we need to know the amplitude, $\mathbf{U}_{\mathbf{q}}$, of the **q**th lattice mode. This will be a function of the temperature. We know that the average energy in this mode is given by (2.47);

$$\bar{\mathscr{E}}_{\mathbf{q}} = (\bar{n}_{\mathbf{q}} + \tfrac{1}{2})\hbar\nu_{\mathbf{q}}, \tag{2.107}$$

where $\bar{n}_{\mathbf{q}}$ is the average number of phonons in the mode, as given by the Bose–Einstein formula (2.46).

Classically, we can calculate the energy of each simple-harmonic oscillator mode as the sum of its kinetic and potential energies. These are known to be equal—so we have, from (2.1) and (2.8),

$$\begin{aligned} \bar{\mathscr{E}} &= \sum_{sl} M_s |\dot{\mathbf{u}}_{sl}|^2 \\ &= \sum_{s\mathbf{q}} N M_s |\dot{\mathbf{U}}_{s\mathbf{q}}|^2 \\ &= \sum_{s\mathbf{q}} N M_s \nu_{\mathbf{q}}^2 |\mathbf{U}_{s\mathbf{q}}|^2. \end{aligned} \tag{2.108}$$

If there is only one atom per unit cell, of mass M, then

$$\begin{aligned} |\mathbf{U}_{\mathbf{q}}|^2 &= \bar{\mathscr{E}}_{\mathbf{q}}/NM\nu_{\mathbf{q}}^2 \\ &= (\bar{n}_{\mathbf{q}} + \tfrac{1}{2})\hbar/NM\nu_{\mathbf{q}}. \end{aligned} \tag{2.109}$$

We know the polarization of $\mathbf{U}_{\mathbf{q}}$ for each branch of the lattice spectrum, so that we can, in principle, calculate the Debye–Waller factor exactly.

To see how it should behave let us assume a Debye model with all three modes having the same velocity. For any one polarization we should find, on the average

$$|\mathbf{K}\cdot\mathbf{U}_{\mathbf{q}}|^2 = \tfrac{1}{3}K^2 |\mathbf{U}_{\mathbf{q}}|^2, \tag{2.110}$$

but with three different polarizations the factor $\tfrac{1}{3}$ is removed.†

---

† There is a useful rule: in this model, the three modes are degenerate at each value of **q**. Therefore one can choose the polarization vectors at will, provided they are orthogonal. One therefore chooses one mode to have $\mathbf{U}_{\mathbf{q}}$ parallel to **K**, the other two normal to **K**. This yields the result we need.

From (2.46), (2.56) and (2.109) we have

$$
\begin{aligned}
W &= \tfrac{1}{2}K^2 \frac{\hbar}{NM} \frac{1}{8\pi^3} \iiint \frac{\bar{n}_{\mathbf{q}} + \frac{1}{2}}{\nu_{\mathbf{q}}} d^3q \\
&= \frac{1}{2} \frac{\hbar^2 K^2}{M} \int_0^{\nu_D} \left\{ \frac{1}{e^{\hbar\nu/kT} - 1} + \frac{1}{2} \right\} \frac{3\nu^2}{\hbar\nu \nu_D^3} d\nu \\
&= \frac{3}{2} \frac{\hbar^2 K^2 T^2}{M k \Theta^3} \int_0^{\Theta/T} \left\{ \frac{1}{e^z - 1} + \frac{1}{2} \right\} z\, dz,
\end{aligned}
\tag{2.111}
$$

as in (2.57).

At high temperatures the upper limit of the integral is small, and the exponential factor in the integrand can be expanded in powers of z. The result is

$$
W \to \frac{3}{2} \frac{\hbar^2 K^2 T}{M k \Theta^2}. \tag{2.112}
$$

Thus, the X-ray diffraction pattern, which is proportional to the square of the matrix element $\mathscr{M}_{\mathbf{k}'\mathbf{k}}$, is reduced in intensity by a factor

$$
e^{-2W} \sim \exp(-3\hbar^2 K^2 T / M k \Theta^2). \tag{2.113}
$$

This factor depends quite strongly on the temperature, and also on the magnitude of the scattering vector. This result would be obtained if we used classical statistics for the average energy of each mode, i.e. $\mathscr{E}_q = kT$.

At temperatures below the Debye temperature the formula is more complicated, but we note that W will tend to a constant at the lowest temperatures. This is due to the term $\frac{1}{2}$ in the integral—a term arising from the *zero-point motion* of the lattice. This is not a negligible effect:

$$
W \to \frac{3}{8} \frac{\hbar^2 K^2}{M k \Theta} \quad \text{as} \quad T \to 0, \tag{2.114}
$$

which is $\frac{1}{4}$ of the value of W at $T \sim \Theta$. Zero-point *energy* may be physically irrelevant, but the *motion* associated with it can be observed directly.

The derivation of (2.111) provides us, incidentally, with another interesting result. It is clear from (2.1) and (2.8) that the mean square amplitude of the vibration of each atom about its lattice site is given by

$$
\begin{aligned}
\frac{1}{N} \sum_l |\mathbf{u}_l|^2 &= \sum_{\mathbf{q}} |\mathbf{U}_{\mathbf{q}}|^2 \\
&\approx \frac{9\hbar^2 T}{M k \Theta^2}
\end{aligned}
\tag{2.115}
$$

above the Debye temperature. At the temperature T the root-mean-square displacement of each atom from its equilibrium site will thus be a fraction x of, say, the mean radius r_s of a unit cell, where

$$x = \sqrt{\frac{9\hbar^2 T}{Mk\Theta^2 r_s^2}}. \tag{2.116}$$

The *Lindemann melting formula* is based upon this idea. It is suggested that a solid must melt when x attains some standard value, x_m. Thus, the melting temperature T_m is related to the other atomic constants of the solid by

$$T_m = \frac{x_m^2}{9\hbar^2} Mk\Theta^2 r_s^2. \tag{2.117}$$

It seems that x_m is in the range 0·2–0·25 in most solids.

This rule may be used to estimate the Debye temperature approximately from knowledge of T_m. It also provides a convenient short cut for estimating values of quantities, like W, which depend on the amplitude of the atomic vibrations. For example, we can show that (2.112) can be written

$$W \approx x_m^2 \frac{T}{T_m} \frac{K^2}{q_D^2}, \tag{2.118}$$

where q_D is the Debye wave-number (2.53).

2.10 Anharmonicity and thermal expansion

At the beginning of this chapter, we expanded the potential energy of the crystal as a Taylor series in the lattice displacements. But this series, (2.2), was curtailed at the second-order term. There will be further terms, such as

$$\mathcal{V}^{(3)} = \sum_{\substack{ss's'' \\ ll'l'' \\ ii'i''}} u_{sl}^{i} u_{s'l'}^{i'} u_{s''l''}^{i''} \left[\frac{\partial^3 \mathcal{V}}{\partial u_{sl}^{i}\, \partial u_{s'l'}^{i'}\, \partial u_{s''l''}^{i''}}\right]_0, \tag{2.119}$$

and so on. The actual calculation of the coefficients is a very complicated problem.

Several important physical phenomena are associated with the *anharmonic terms*. Of these the most familiar is *thermal expansion*. It is not easy to derive this directly from expressions like (2.119), but the general physical idea is easy enough. As the temperature rises the amplitude of the lattice vibrations increases, so that the average R.M.S. values of the displacements $\mathbf{u}_{sl}$, etc., increase. The anharmonic terms contribute to the free energy of the crystal, which is now no longer

```
//TWOTEMP JOB (J348IBM,209,1,3),'----GLENZER----)'
/*  SERVICE  CLASS=Q
//YES EXEC WATFIV
//GO.SYSIN DD *
$WATFIV
C** LINEAR REDUCTION OF DIFFRATION DATA (INTEGRATED INTENSITIES)
C          FOR ZINC-BLENDE STRUCTURE POWDERS
C          TO PRODUCE TWO DEBYE-WALLER FACTORS
C
C    PROGRAM WILL HANDLE ALL POSSIBLE PAIRS OF PEAKS.  PEAK TYPES
C       IDENTIFIED BY FIRST TWO VARIABLES ON DATA CARDS,
C       KEY-LETTERS, 'E','O','R' REPRESENTING EVEN,ODD, AND RIGHT-
C       ANGLE PEAKS
      REAL *4 KAPA,KAPB
      COMMON /WAVELN/ FLAMBD
      DATA IDENO,IDENE,IDENR /'O','E','R'/
      REAL*4 W1(3) /1.,10.,.1/
      REAL*4 TTTX(5) /77.,77.,144.,144.,77./
      REAL*4 TTTY(5) /116.,232.,116.,232.,58./
C **ALPHA IS THE PERCENTAGE OF CRYSTALLITES IN HG-TE-EMPTY-EMPTY
C         ORIENTATION
      FLAMBD=.7093
      BUNCHF=0.1*(174.0*FLAMBD**2/(300.0*80.0))
 100  READ (5,737,END=599) IDENA,IDENB,T1,T2,ANGLEA,ANGLEB,FINT1A,
     1     FINT1B,FINT2A,FINT2B,ALPHA
 737  FORMAT (2A1,2F6.1,2F7.2,4F8.2,F4.1)
      WRITE (6,739) T1,T2,ANGLEA,ANGLEB,FINT1A,FINT1B,FINT2A,FINT2B,
     1    ALPHA,IDENA,IDENB
 739  FORMAT ('1DATA--'/5X,2F6.1,2F6.2,4F9.1,F6.1/5X,A1,'  PEAK-A'/
     1     5X,A1,'  PEAK-B')
      THETAA=(ANGLEA/2.0)/57.3
      THETAB=(ANGLEB/2.0)/57.3
      FZERO=ATOMFC(THETAA,8)
      CALL CMPLXF (2,THETAA,FLAMBD,FZERO,FXA,PHIXA)
      FZERO=ATOMFC(THETAB,8)
      CALL CMPLXF (2,THETAB,FLAMBD,FZERO,FXB,PHIXB)
      FZERO=ATOMFC(THETAA,2)
      CALL CMPLXF (1,THETAA,FLAMBD,FZERO,FYA,PHIYA)
      FZERO=ATOMFC(THETAB,2)
      CALL CMPLXF (1,THETAB,FLAMBD,FZERO,FYB,PHIYB)
      DPHIA=PHIXA-PHIYA
      DPHIB=PHIXB-PHIYB
      DO 599 IT=1,5
      THDBXC=TTTX(IT)
      THDBYC=TTTY(IT)
      WRITE (6,739) T1,T2,ANGLEA,ANGLEB,FINT1A,FINT1B,FINT2A,FINT2B,
     1    ALPHA,IDENA,IDENB
      WRITE (6,7713) THDBXC,THDBYC
 7713 FORMAT (' DEBYE TEMPERATURES',2F11.5,5X,2E13.4)
      PSIA=2.0*(2.0*3.14159*SIN(THETAA)/FLAMBD)**2
      PSIB=2.0*(2.0*3.14159*SIN(THETAB)/FLAMBD)**2
      ETAB2=FINT1B/FINT2B
      ETAA2=FINT1A/FINT2A
      FMASSX=200.6
      FMASSY=127.6
      CHIX=146./FMASSX
      CHIY=146./FMASSY
      DO 500 ITIMES=1,20
      ZX1=THDBXC/T1
      ZX2=THDBXC/T2
      ZY1=THDBYC/T1
      ZY2=THDBYC/T2
      UX1=(CHIX/(ZX1*THDBXC))*(DEBYE1(ZX1)+ZX1/4.)
      UX2=(CHIX/(ZX2*THDBXC))*(DEBYE1(ZX2)+ZX2/4.)
      UY1=(CHIY/(ZY1*THDBYC))*(DEBYE1(ZY1)+ZY1/4.)
      UY2=(CHIY/(ZY2*THDBYC))*(DEBYE1(ZY2)+ZY2/4.)
      GAX1=(FXA*EXP(-PSIA*UX1))**2
      GAX2=(FXA*EXP(-PSIA*UX2))**2
      GAY1=(FYA*EXP(-PSIA*UY1))**2
      GAY2=(FYA*EXP(-PSIA*UY2))**2
      GBX1=(FXB*EXP(-PSIB*UX1))**2
      GBX2=(FXB*EXP(-PSIB*UX2))**2
      GBY1=(FYB*EXP(-PSIB*UY1))**2
      GBY2=(FYB*EXP(-PSIB*UY2))**2
C** CHANGE CONVERGENCE VARIABLE TO 1/THETA, WHICH CAN BE ACCOMPLISHED
C        INSERTING AN EXTRA (-THETA**2)
      VX1=(CHIX/T1**2)*VVDEB(ZX1)*(-THDBXC**2)
      VX2=(CHIX/T2**2)*VVDEB(ZX2)*(-THDBXC**2)
      VY1=(CHIY/T1**2)*VVDEB(ZY1)*(-THDBYC**2)
      VY2=(CHIY/T2**2)*VVDEB(ZY2)*(-THDBYC**2)
      CALL CROSST (GAX1,GAX2,GAY1,GAY2,IDENA,DPHIA,ALPHA,HA1,HA2)
      CALL CROSST (GBX1,GBX2,GBY1,GBY2,IDENB,DPHIB,ALPHA,HB1,HB2)
C     WRITE (6,715) ITIMES,GAX1,GAX2,GAY1,GAY2,GBX1,GBX2,GBY1,GBY2,
C    1     HA1,HA2,HB1,HB2
C715  FORMAT ('0  ON STEP',I6,'  INDIVIDUAL TERMS ARE'/1X,12E11.4)
      C1=GAX1+GAY1+2.0*HA1-ETAA2*(GAX2+GAY2+2.0*HA2)
      C2=GBX1+GBY1+2.0*HB1-ETAB2*(GBX2+GBY2+2.0*HB2)
      D11=2.0*PSIA*(VX1*(GAX1+HA1)-ETAA2*VX2*(GAX2+HA2))
      D12=2.0*PSIA*(VY1*(GAY1+HA1)-ETAA2*VY2*(GAY2+HA2))
      D21=2.0*PSIB*(VX1*(GBX1+HB1)-ETAB2*VX2*(GBX2+HB2))
      D22=2.0*PSIB*(VY1*(GBY1+HB1)-ETAB2*VY2*(GBY2+HB2))
C     WRITE (6,713) C1,C2,D11,D12,D21,D22
C713  FORMAT ('  WORKING VARIABLES ARE'/10X,6E12.4)
      DET=D11*D22-D12*D21
      QX1  =(C1*D22-D12*C2)/DET
      QY1  =(D11*C2-C1*D21)/DET
      QX0=1./THDBXC+QX1
      QY0=1./THDBYC+QY1
      THDBXC=1./QX0
      THDBYC=1./QY0
      WRITE (6,7714) THDBXC,THDBYC,QX0,QY0,QX1,QY1
 7714 FORMAT (' DEBYE TEMPERATURES',2F11.5,5X,4E14.5)
      IF (THDBXC.LE.20. .OR. THDBYC.LE.20.) GO TO 501
      IF (ABS(QX1/QX0).LE..00001 .AND. ABS(QY1/QY0).LE..00001) GO TO 510
  500 CONTINUE
  501 ENDA=(GAX1+GAY1+2.0*HA1)/(GAX2+GAY2+2.0*HA2)
      ENDB=(GBX1+GBY1+2.0*HB1)/(GBX2+GBY2+2.0*HB2)
      WRITE (6,7719) ETAA2,ETAB2,ENDA,ENDB
 7719 FORMAT ('0  CONVERGENCE UNSATISFACTORY',5X,4F10.6)
  502 CONTINUE
      GO TO 599
C ** CALCULATE RATIOS USING FINAL PARAMETER VALUES
```

```
 510  CONTINUE
      ENDA=(GAX1+GAY1+2.0*HA1)/(GAX2+GAY2+2.0*HA2)
      ENDB=(GBX1+GBY1+2.0*HB1)/(GBX2+GBY2+2.0*HB2)
      WRITE (6,721) ETAA2,ETAB2,ENDA,ENDB
 721  FORMAT ('0 FINAL--',' EXPERIMENTAL RATIOS',15X,'DERIVED RATIOS'
     1    /7X,2F14.9,5X,2F14.9)
 599  CONTINUE
 600  GO TO 100
 999  STOP
      END
      FUNCTION VVDEB(Z)
C** CALCULATES SOME FIRST DERIVATIVE OF THE FIRST DEBYE INTEGRAL AND
C        ANOTHER TERM, I.E. MEAN SQUARE DISPLACEMENT
      VVDEB=(-3.0*DEBYE1(Z)/Z**3 +1.0/(Z**2*(EXP(Z)-1.0))-.25/Z**2)
      RETURN
      END
      FUNCTION ATOMFC (THET,IJ)
C  /*THESE ARE THE ATOMIC SCATTERING FACTORS
C     TAKEN FROM L.H.THOMAS AND K.UMEDA  J.CHEM.PHYS.26,293, 1957
C  */
C/*    Z=48 ++IONIZED     */
C/* Z=52,  0 IONIZED   */
C/*  LINEAR COMBINATION OF Z=52 AND Z=54 BOTH NEUTRAL    */
C/*   Z=54  NEUTRAL             */
C/*   Z=80    ++ IONIZED   */
C/*   Z=15  NEUTRAL GALLIUM   */
C/*   Z=15  NEUTRAL PHOSPHOROUS  */
C/*        Z=80   NEUTRAL MERCURY          */
      REAL*4 SCFAC (31,8)
      REAL*4 DD1(31)  /
     A46.00,45.42,43.80,41.43,38.66,35.84,33.22,30.88,28.83,27.00,25.35,
     A23.83,22.43,21.16,20.00,18.96,17.99,17.10,16.28,15.52,14.81,14.16,
     A13.56,12.99,12.46,11.97,11.51,11.07,10.66,10.28,9.92/
      REAL*4 DD2(31)  /
     A52.00,51.00,48.40,45.13,41.92,39.01,36.35,33.90,31.67,29.68,27.87,
     A26.22,24.71,23.35,22.10,20.95,19.89,18.92,18.03,17.20,16.42,15.71,
     A15.05,14.42,13.84,13.30,12.79,12.31,11.86,11.44,11.04/
      REAL*4 DD3(31)  /
     A54.00,52.83,50.06,46.99,43.20,40.12,37.30,34.69,32.33,30.22,28.30,
     A26.54,24.94,23.50,22.17,20.95,19.89,13.92,18.03,17.20,16.42,15.71,
     A15.05,14.42,13.84,13.30,12.79,12.31,11.86,11.44,11.04/
      REAL*4 DD4(31)  /
     A54.00,52.97,50.32,46.96,43.66,40.67,37.93,35.39,33.09,31.02,29.16,
     A27.44,25.87,24.46,23.16,21.96,20.86,19.85,18.92,18.05,17.24,16.49,
     A15.80,15.15,14.54,13.97,13.44,12.94,12.47,12.03,11.61/
      REAL*4 DD5(31)  /
     A78.00,77.12,74.85,71.05,66.90,62.71,58.79,55.25,52.05,49.13,46.41,
     A43.90,41.59,39.47,37.53,35.73,34.06,32.52,31.08,29.74,28.40,27.33,
     A26.25,25.22,24.27,23.37,22.52,21.72,20.97,20.26,19.59/
      REAL*4 DD6(31)  /
     A28.00,27.70,26.84,25.52,23.90,22.14,20.39,18.76,17.30,16.03,14.93,
     A13.94,13.11,12.33,11.61,10.94,10.33,9.78,9.29,8.83,8.40,8.01,
     A7.64,7.21,6.99,6.70,6.43,6.17,5.94,5.71,5.50/
      REAL*4 DD7(31)  /
     A15.00,14.47,13.17,11.66,10.34,9.33,8.49,8.02,7.54,7.54,
     A6.67,6.67,5.83,5.83,5.01,5.02,4.28,4.28,3.64,3.64,3.11,3.11,
     A2.69,2.69,2.35,2.35,2.10,2.10,1.89,1.89,1.75/
      REAL*4 DD8(31)  /
     A80.00,78.89,75.31,70.99,66.66,62.62,58.84,55.30,52.06,49.11,
     A46.40,43.89,41.59,39.48,37.54,35.73,34.06,32.52,31.08,29.74,
     A28.50,27.33,26.25,25.22,24.27,23.37,22.52,21.72,20.97,20.26,
     A19.27      /
      DO 1 I=1,31
      SCFAC(I,1)=DD1(I)
      SCFAC(I,2)=DD2(I)
      SCFAC(I,3)=DD3(I)
      SCFAC(I,4)=DD4(I)
      SCFAC(I,5)=DD5(I)
      SCFAC(I,6)=DD6(I)
      SCFAC(I,8)=DD8(I)
    1 SCFAC(I,7)=DD7(I)
      REAL*4 THETA(200),INTEN(200),REDINT(200),WT(200),REDCLC(200)
      INTEGER M1(200),M2(200),M3(200),ITYP(200),NTYPE(3)/3*0/
      COMMON /WAVELN/FLAMBD
      PARAM=SIN(THET)/FLAMBD
      IF (PARAM.GE.0.0  .AND. PARAM.LE.1.5) GO TO 200
      WRITE (6,121) THETA
  121 FORMAT('1   ATOMIC SCATTERING FACTOR TABLE IS INSUFFICIENT FOR'
     1  ,' THETA =',F8.3)
      STOP
  200 ISUB=PARAM/.05
      ALPHA=PARAM/.05 - FLOAT(ISUB)
      ATOMFC=((SCFAC(ISUB+1,IJ))**(1.0-ALPHA))*((SCFAC(ISUB+2,IJ))**
     1    ALPHA)
      RETURN
      END
      SUBROUTINE CMPLXF (I,THETA,FLAM,FZERO,FMAG,FPHASE)
C**  DISPERSIVE PARTS OF THE SCATTERING FACTOR ARE LINEARLY INTERPOLATED
C      FROM TABLES IN THE CRYSTALLOGRAPHY TABLES FOR MO-RADIATION AND
C      THEN COMBINED WITH THE ZERO-ORDER PART,FZERO, AND THE MAGNITUDE
C      AND PHASE RETURNED.
C     VALUES ARE FROM  INTERNATIONAL TABLES OF X-RAY CRYST.
C      III P.215
C     THEY ARE ARRANGED TE,HG,P,GA
      REAL*4 FR(4,3) /-.5,-.7,-.8,-2.6,-2.9,-3.0,
     A                  0.1,0.1,0.1,0.2,0.2,0.2/,
     1       FI(4,4) /2.2,2.0,1.8,1.5,10.6,10.1,9.7,9.0,
     A                  0.2,0.2,0.1,0.1,1.7,1.6,1.6,1.5/
      FKAP=SIN(THETA)/FLAM
      IF (FKAP.GE.0.0 .AND. FKAP.LE.0.6) GO TO 110
      IF (FKAP.GE.0.6 .AND. FKAP.LE.0.9) GO TO 120
      IF (FKAP.GE.0.0 .AND. FKAP.LE.1.3) GO TO 130
      WRITE (6,213) THETA,FLAM
  213 FORMAT (' TOO LARGE FOR TABLES IN CMPLXF',2E12.4)
      STOP
  110 FIMAG=FI(I,1)+(FI(I,2)-FI(I,1))*FKAP/0.6
      GO TO 125
  120 FIMAG=FI(I,2)+(FI(I,3)-FI(I,2))*(FKAP-0.6)/(0.9-0.6)
  125 FREAL=FR(I,1)+(FR(I,2)-FR(I,1))*FKAP/0.9
      GO TO 200
  130 FIMAG=FI(I,3)+(FI(I,4)-FI(I,3))*(FKAP-0.9)/(1.3-0.9)
      FREAL=FR(I,2)+(FR(I,3)-FR(I,2))*(FKAP-0.9)/(1.3-0.9)
```

```
 200  FMAG=SQRT((FZERO+FREAL)**2+FIMAG**2)
      FPHASE=ATAN(FIMAG/(FZERO+FREAL))
      WRITE (6,227) FZERO,FREAL,FIMAG,FMAG,FPHASE
 227  FORMAT (' SCATTERING FACTORS',5F12.6)
      RETURN
      END
      SUBROUTINE CROSST (GAX1,GAX2,GAY1,GAY2,IDENA,DPHIA,ALPHA,HA1,HA2)
C ** THIS SUBROUTINE CALCULATES THE CROSS TERM IN THE INTENSITY
C        EXPRESSION (INCLUDING DISPERSIVE EFFECTS).  THE FORM OF THE
C        EXPRESSION DEPENDS ON IDENA
      DATA IDENO,IDENE,IDENR /'O','E','R'/
      IF (IDENA.EQ.IDENE) GO TO 410
      IF (IDENA.EQ.IDENO) GO TO 420
      IF (IDENA.EQ.IDENR) GO TO 430
      STOP 409
 410  HA1=SQRT(GAX1*GAY1)*COS(DPHIA)
      HA2=SQRT(GAX2*GAY2)*COS(DPHIA)
      GO TO 450
 420  HA1=-SQRT(GAX1*GAY1)*COS(DPHIA)
      HA2=-SQRT(GAX2*GAY2)*COS(DPHIA)
      GO TO 450
 430  HA1=SQRT(GAX1*GAY1)*SIN(DPHIA)*(2.0*ALPHA-1.0)
      HA2=SQRT(GAX2*GAY2)*SIN(DPHIA)*(2.0*ALPHA-1.0)
      GO TO 450
 450  CONTINUE
      RETURN
      END
      FUNCTION DEBYE1(Y)
C**FUNCTION TO CALCULATE THE DEBYE INTEGRAL OF ORDER 1 DIVIDED BY THE
C        ARGUMENT WHICH IS COMMONLY CALLED PHI IN LATTICE DYNAMICS
      X=Y
      IF (X) 100,200,200
 100  WRITE (6,222)
 222  FORMAT (' NEGATIVE ARG IN DEBYE1')
      STOP
 200  IF (X-1.0) 1000,2000,2000
 1000 F1=1.666666667D-1/(3.0*2.0)
      F2=-3.333333333D-2/(5.0*24.0)
      F3=+2.380952381D-2/(7.0*4.2D+2)
      F4=-3.333333333D-2/(9.0*4.0320D+4)
      F5=7.575757576D-2/(11.0*3.628800D+6)
      F6=-2.531135531D-1/(13.0*4.790016D+8)
      F7=1.166666667D0/(15.0*8.66992896D+10)
      DEBYE1=1.0-X/4.0+F1*X**2+F2*X**4+F3*X**6+F4*X**8+F5*X**10
     1     +F6*X**12+F7*X**14
      RETURN
 2000 ZETA2=1.644934066848226
      SUM=0.0
      DO 2100 K=1,25
      IF (K*X.GT.15.0) GO TO 2200
 2100 SUM=SUM+EXP(-K*X)/K**2
 2200 DEBYE1=ZETA2/X+ALOG(1.0-EXP(-X))-SUM/X
      RETURN
      END
$DATA
EO 186.0  81.0 122.95  66.54 1187.83  508.5810913.50 2391.59 0.0
EO 298.0 188.0  52.08  66.5423510.11  278.6742482.99  508.58 0.0
EO 298.0 188.0  82.32  66.54 1732.55  278.67 5920.33  508.58
EO 188.0  81.0  52.08  66.5442482.99  508.5879864.96 2391.59 0.0
EO 188.0  81.0  82.32  66.54 5920.33  508.5823983.14 2391.59 0.0
EO 298.0  81.0  52.08  66.5423510.11  278.6779864.96 2391.59
EO 298.0  81.0  82.32  66.54 1732.55  278.6723963.14 2391.59 0.0
$STOP
/*
```

F3 FOURIER

Pages "92" through "94" describe a subroutine for calculating Fourier coefficients using Romberg integration. Pages "95" and "96" contain listings of the main program and required subroutines. Data is listed at the bottom of page "96," and required output is shown on page "97."

EXAMPLE 2.2

FOURIER COEFFICIENTS USING ROMBERG INTEGRATION

Problem Statement

Write a general-purpose subroutine named TROMB that uses the Romberg integration algorithm outlined in Section 2.7 to evaluate numerically the integral

$$\int_a^b f(x)\,dx \qquad (2.2.1)$$

where $f(x)$ is any single-valued function and a and b are finite. The program should first use the trapezoidal rule with repeated interval halving to determine $T_{0,1}, T_{1,1}, \ldots, T_{N_{max},1}$ from (2.52a) and the recursion relation (2.53). Then the Romberg sequences $\{T_{N,j}\}$ should be computed from the general extrapolation formula (2.61) for all $j \leqslant j_{max}$. The Romberg Tableau should be organized as illustrated in Table 2.1.

To test the subroutine, write a general purpose program that calls on TROMB to evaluate the coefficients of the Fourier expansion for any arbitrary function $g(x)$, periodic with period 2π, such that $g(x) = g(x + 2k\pi)$ for integral k. The Fourier expansion may be written [14]

$$g(x) = \sum_{m=0}^{\infty} c_m \cos mx + \sum_{m=0}^{\infty} d_m \sin mx, \qquad (2.2.2)$$

where

$$c_m = \frac{1}{\pi}\int_{-\pi}^{\pi} g(x) \cos mx\, dx \qquad (2.2.3)$$

$$d_m = \frac{1}{\pi}\int_{-\pi}^{\pi} g(x) \sin mx\, dx. \qquad (2.2.4)$$

Write the program so that the coefficients (c_m, d_m) are calculated in pairs, for $m = 0, 1, \ldots, m_{max}$.

As a test periodic function, $g(x)$, use the sawtooth function of Fig. 2.2.1.

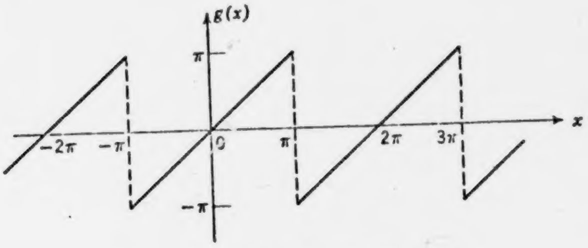


Figure 2.2.1 A periodic sawtooth function.

Method of Solution

The subroutine TROMB is a straightforward implementation of the trapezoidal rule of (2.52a),

$$T_{0,1} = (b - a)[f(a) + f(b)]/2,$$

followed by repeated interval halving using the recursion relation of (2.53),

$$T_{N,1} = \frac{1}{2}\left\{T_{N-1,1} + \frac{(b-a)}{2^{N-1}} \sum_{\substack{i=1\\ \Delta i=2}}^{2^N - 1} f\left(a + \frac{(b-a)}{2^N}\, i\right)\right\},$$

for $N = 1, 2, \ldots, N_{max}$. The Romberg extrapolation formula of (2.61),

$$T_{N,j} = \frac{4^{j-1}T_{N+1,j-1} - T_{N,j-1}}{4^{j-1} - 1},$$

is then employed for $j = 2, 3, \ldots, j_{max}$, with $N = 0, 1, \ldots, N_{max} - j + 1$, to fill out the remaining elements in the first j_{max} columns of the matrix T.

The integrands for the integrals of (2.2.3) and (2.2.4),

$$f_c(x) = [g(x) \cos mx]/\pi, \qquad (2.2.5)$$

$$f_d(x) = [g(x) \sin mx]/\pi, \qquad (2.2.6)$$

are evaluated by the functions FUNCTC and FUNCTD, respectively, defined in one multiple-entry function. The periodic function $g(x)$, which for the suggested function of Fig. 2.2.1 is given by

$$g(x) = x, \qquad (2.2.7)$$

is also defined in the multiple-entry function.

From (2.2.4), it is clear that for all $g(x)$, $d_0 = 0$. For the periodic function of (2.2.7), the coefficients c_m and d_m of (2.2.3) and (2.2.4) may be found analytically, and are given by

$$c_m = \frac{1}{\pi}\int_{-\pi}^{\pi} x \cos mx\, dx = 0, \qquad m = 0, 1, \ldots \qquad (2.2.8)$$

$$d_m = \frac{1}{\pi}\int_{-\pi}^{\pi} x \sin mx\, dx = -\frac{2}{m}\cos m\pi = -\frac{2}{m}(-1)^m,$$

$$m = 1, 2, \ldots \qquad (2.2.9)$$

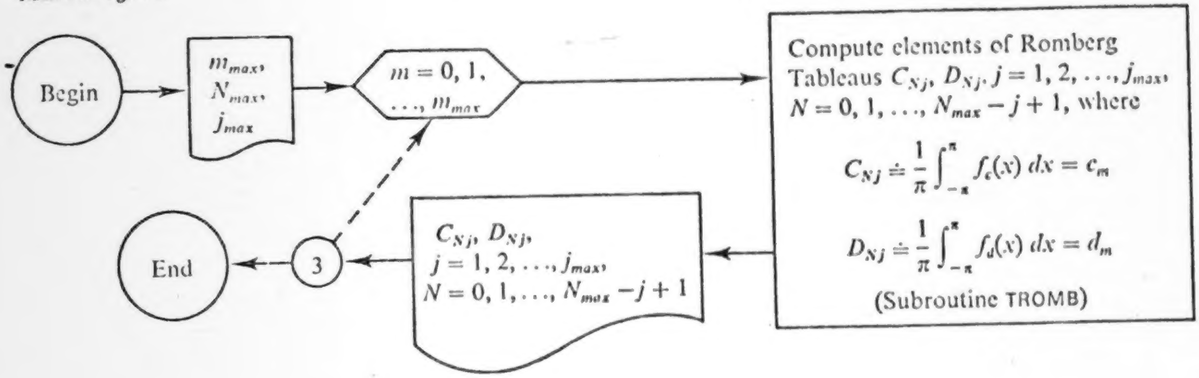
Then the Fourier expansion of (2.2.7) is

$$g(x) = x = 2\left(\sin x - \frac{\sin 2x}{2} + \frac{\sin 3x}{3} - \ldots\right). \qquad (2.2.10)$$

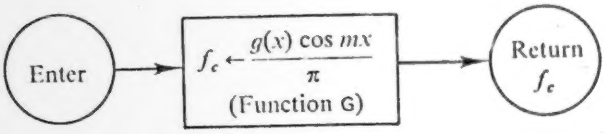
In the programs that follow, all c_m and d_m are evaluated for $m = 0, 1, \ldots, m_{max}$. The Romberg tableaus for c_m and d_m are stored in the matrices C and D respectively.

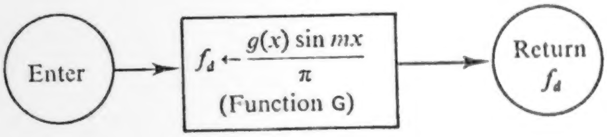
Flow Diagram

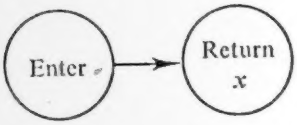
Main Program


Begin
m_{max}, N_{max}, j_{max}
$m = 0, 1, \ldots, m_{max}$
Compute elements of Romberg Tableaus C_{Nj}, D_{Nj}, $j = 1, 2, \ldots, j_{max}$, $N = 0, 1, \ldots, N_{max} - j + 1$, where
$C_{Nj} \doteq \frac{1}{\pi}\int_{-\pi}^{\pi} f_c(x)\,dx = c_m$
$D_{Nj} \doteq \frac{1}{\pi}\int_{-\pi}^{\pi} f_d(x)\,dx = d_m$
(Subroutine TROMB)
C_{Nj}, D_{Nj}, $j = 1, 2, \ldots, j_{max}$, $N = 0, 1, \ldots, N_{max} - j + 1$
3
End

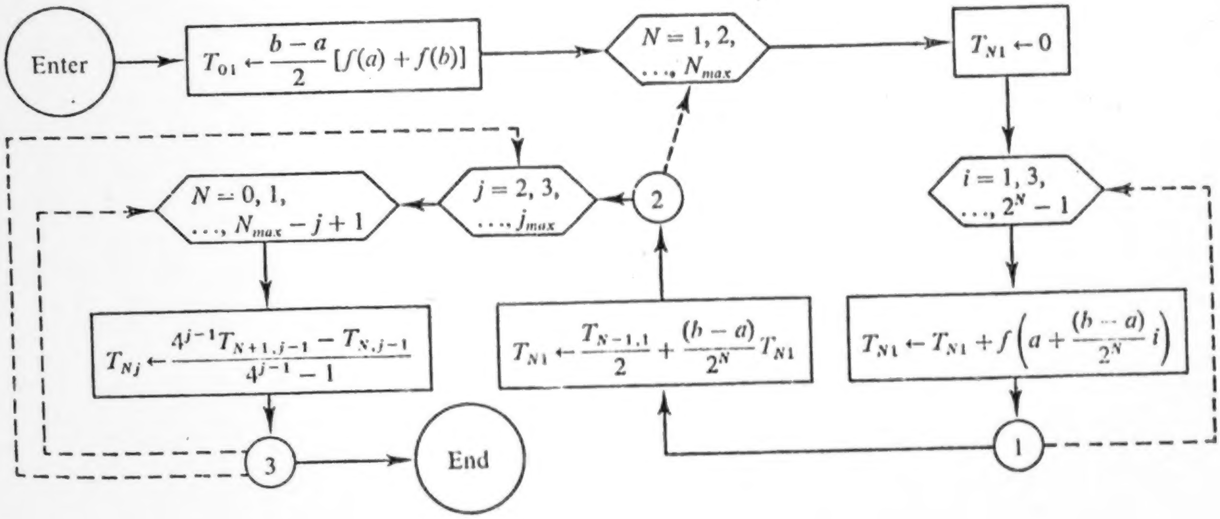
Functions FUNCTC, FUNCTD, G (Argument: x)


Enter
$f_c \leftarrow \frac{g(x)\cos mx}{\pi}$
(Function G)
Return f_c


Enter
$f_d \leftarrow \frac{g(x)\sin mx}{\pi}$
(Function G)
Return f_d


Enter
Return x

Subroutine TROMB (Dummy arguments: N_{max}, a, b, f, T, j_{max}, n;
calling arguments: N_{max}, $-\pi$, π, FUNCTC or FUNCTD, C or D, j_{max}, n)


Enter
$T_{01} \leftarrow \frac{b-a}{2}[f(a) + f(b)]$
$N = 1, 2, \ldots, N_{max}$
$T_{N1} \leftarrow 0$
$i = 1, 3, \ldots, 2^N - 1$
$T_{N1} \leftarrow T_{N1} + f\left(a + \frac{(b-a)}{2^N} i\right)$
1
$T_{N1} \leftarrow \frac{T_{N-1,1}}{2} + \frac{(b-a)}{2^N} T_{N1}$
2
$j = 2, 3, \ldots, j_{max}$
$N = 0, 1, \ldots, N_{max} - j + 1$
$T_{Nj} \leftarrow \frac{4^{j-1} T_{N+1,j-1} - T_{N,j-1}}{4^{j-1} - 1}$
3
End

FORTRAN *Implementation*

List of Principal Variables

Program Symbol	*Definition*
(Main)	
C, D†	Matrices C and D, containing the Romberg tableaus for c_m and d_m, respectively.
J	Column subscript for tableaus, j.
JM	Maximum column subscript in Nth row of tableau.
JMAX	j_{max}, number of columns in tableau.
M	m, index on Fourier coefficients c_m and d_m.
MMAX	m_{max}, maximum value of m.
N†	Row subscript for tableaus, N.
NMAX	N_{max}, maximum value of N.
NMAXP1	$N_{max} + 1$.
PI	π.
MMAXP1	$m_{max} + 1$.
MPLUS1	$m + 1$.
(Functions FUNCTC, FUNCTD, G)	
X	The variable of integration, x.
(Subroutine TROMB)	
A, B	Lower and upper limits of integration, a and b.
F	The integrand function, f.
FR	$(b - a)/2^N$.
FORJM1	4^{j-1}.
H	$b - a$.
I	i, index on repeated sum of (2.53).
IMAX	$2^N - 1$.
NRC	n, number of rows and columns in tableau T.
NXMJP2	$N_{max} - j + 2$.
T†	Matrix containing the Romberg tableau, T.

† Because of FORTRAN limitations, the row subscripts of the text and flow diagrams are advanced by one when they appear in the program. For example, N assumes values 1, 2, ..., $N_{max} + 1$, so that $T_{0,1}$ = T(1, 1), $T_{N_{max},1}$ = T(N_{max} + 1, 1), etc.

Program Listing

Main Program

```
C       APPLIED NUMERICAL METHODS, EXAMPLE 2.2
C       FOURIER COEFFICIENTS USING ROMBERG INTEGRATION
C
C       THIS TEST PROGRAM CALLS ON THE SUBROUTINE TROMB TO COMPUTE
C       THE INTEGRALS NECESSARY TO DETERMINE THE COEFFICIENTS
C       OF THE FOURIER EXPANSION FOR A FUNCTION G(X) ON THE
C       INTERVAL (-PI,PI) WHERE THE FUNCTION IS PERIODIC FOR ALL
C       X SUCH THAT G(X) = G(X + 2*K*PI), K BEING AN
C       INTEGER.  THE FIRST MMAX COEFFICIENTS OF THE COSINE AND
C       SINE TERMS (THE C(M) AND D(M) OF THE TEXT) ARE COMPUTED
C       USING THE TRAPEZOIDAL RULE WITH REPEATED INTERVAL HALVING
C       FOLLOWED BY THE ROMBERG EXTRAPOLATION PROCEDURE.  THE ROMBERG
C       TABLEAUS FOR C(M) AND D(M) ARE STORED IN THE UPPER TRIANGULAR
C       PORTIONS OF THE FIRST NMAX+1 ROWS OF THE FIRST JMAX COLUMNS OF
C       THE C AND D MATRICES RESPECTIVELY.  FOURIER COEFFICIENTS
C       FOR ANY ARBITRARY PERIODIC FUNCTION CAN BE FOUND BY DEFINING
C       G(X) APPROPRIATELY (SEE THE FUNCTIONS FUNCTC AND FUNCTD).
C
      IMPLICIT  REAL*8(A-H, O-Z)
      DIMENSION C(20,20), D(20,20)
      EXTERNAL  FUNCTC, FUNCTD
      COMMON M
      DATA  PI / 3.1415926535898 /
C
C     ..... READ DATA, CALL TROMB TO COMPUTE INTEGRALS .....
    1 READ (5,100)  MMAX, NMAX, JMAX
      WRITE (6,200)  MMAX, NMAX, JMAX
      MMAXP1 = MMAX + 1
      DO 3  MPLUS1=1,MMAXP1
      M = MPLUS1 - 1

      CALL TROMB( NMAX, -PI, PI, FUNCTC, C, JMAX, 20 )
      CALL TROMB( NMAX, -PI, PI, FUNCTD, D, JMAX, 20 )
C
C     ..... PRINT OUT ROMBERG TABLEAUS .....
      WRITE (6,201)  M
      NMAXP1 = NMAX + 1
      DO 2  N=1,NMAXP1
      JM = JMAX
      IF ( N.GT.NMAXP1+1-JMAX )    JM = NMAXP1 + 1 - N
    2 WRITE (6,202)    (C(N,J), J=1,JM)
      WRITE (6,203)  M
      DO 3  N=1,NMAXP1
      JM = JMAX
      IF ( N.GT.NMAXP1+1-JMAX )    JM = NMAXP1 + 1 - N
    3 WRITE (6,202)    (D(N,J), J=1,JM)
      GO TO 1
C
C     ..... FORMATS FOR INPUT AND OUTPUT STATEMENTS .....
  100 FORMAT( 7X, I3, 2(12X, I3) )
  200 FORMAT( 8H1MMAX = , I2/ 8H NMAX = , I2/ 8H JMAX = , I2 )
  201 FORMAT( 1H0/ 1H0,9X,2HC(,I2,1H)/ 1H  )
  202 FORMAT( 1H , 1P7E17.8 )
  203 FORMAT( 1H0/ 1H0,9X,2HD(,I2,1H)/ 1H  )
C
      END
```

Functions FUNCTC, FUNCTD, G

```
      FUNCTION FUNCTC( X )
C
C         THE FUNCTIONS FUNCTC AND FUNCTD COMPUTE RESPECTIVELY THE
C         INTEGRAND FOR THE M(TH) COEFFICIENT OF THE COSINE AND SINE
C         TERMS OF THE FOURIER EXPANSION OF THE PERIODIC FUNCTION
C         G(X) = X.
```

Program Listing (*Continued*)

```
C
      IMPLICIT  REAL*8(A-H, O-Z)
      REAL*8  X, FUNCTC, FUNCTD
      COMMON M
      DATA  PI / 3.1415926535898 /
C
C     ..... DEFINE PERIODIC FUNCTION .....
      G(X) = X
C
      FUNCTC = G(X)*DCOS(FLOAT(M)*X)/PI
      RETURN
C
      ENTRY FUNCTD( X )
      FUNCTD = G(X)*DSIN(FLOAT(M)*X)/PI
      RETURN
C
      END
```

Subroutine TROMB

```
      SUBROUTINE TROMB( NMAX, A, B, F, T, JMAX, NRC )
C
C         THE SUBROUTINE TROMB FIRST APPROXIMATES THE INTEGRAL OF
C         F(X)*DX ON THE INTERVAL (A,B) USING THE TRAPEZOIDAL
C         RULE WITH REPEATED INTERVAL HALVING.  T(N+1,1) IS THE VALUE
C         OF THE INTEGRAL COMPUTED AFTER THE N(TH) INTERVAL-HALVING
C         OPERATION.  ALL T(N+1,1) VALUES ARE COMPUTED FOR N = 0 TO
C         N = NMAX.  H IS THE LENGTH OF THE STARTING INTERVAL (A,B).
C         REMAINING ELEMENTS OF THE ROMBERG TABLEAU ARE THEN ENTERED
C         INTO THE FIRST JMAX COLUMNS OF THE FIRST NMAX+1 ROWS OF THE
C         MATRIX T.
C
      IMPLICIT  REAL*8(A-H, O-Z)
      REAL*8  A, B, F, T
      DIMENSION T(NRC,NRC)
C
C     ..... COMPUTE H AND FIRST INTEGRAL APPROXIMATION .....
      H = B - A
      T(1,1) = (F(A) + F(B))*H/2.0
C
C     ..... HALVE INTERVAL REPEATEDLY, COMPUTE T(N+1,1) .....
      DO 2   N=1,NMAX
      T(N+1,1) = 0.0
      FR = H/2.0**N
      IMAX = 2**N - 1
      DO 1   I = 1,IMAX,2
    1 T(N+1,1) = T(N+1,1) + F(FLOAT(I)*FR + A)
    2 T(N+1,1) = T(N,1)/2.0 + H*T(N+1,1)/2.0**N
C
C     ..... COMPUTE ROMBERG TABLEAU .....
      DO 3   J=2,JMAX
      NXMJP2 = NMAX - J + 2
      FORJM1 = 4.0**(J-1)
      DO 3   N=1,NXMJP2
    3 T(N,J) = (FORJM1*T(N+1,J-1) - T(N,J-1))/(FORJM1 - 1.0)
C
      RETURN
C
      END
```

Data

```
MMAX =  10     NMAX =  13     JMAX =   7
```

Computer Output (*abbreviated*)

```
      MMAX =  10
      NMAX =  13
      JMAX =   7


          C( 0)

    0.0              -4.44089210D-15  -8.88178420D-16  -5.90968360D-16  -3.54160573D-16  -1.11505611D-15  -1.56736905D-15
   -3.33066907D-15   -1.11022302D-15  -5.95612267D-16  -3.55085603D-16  -1.11431304D-15  -1.56725862D-15  -6.13269043D-16
   -1.66533454D-15   -6.27775439D-16  -3.58843832D-16  -1.11134731D-15  -1.56681629D-15  -6.13501951D-16  -3.10371843D-15
   -8.87165214D-16   -3.75652058D-16  -1.09952945D-15  -1.56503712D-15  -6.14432922D-16  -3.10311047D-15  -3.62401184D-15
   -5.03530347D-16   -1.05434336D-15  -1.55776450D-15  -6.18146220D-16  -3.10068012D-15  -3.62388466D-15  -3.91411263D-15
   -9.16640106D-16   -1.52630068D-15  -6.32827755D-16  -3.09098272D-15  -3.62337372D-15  -3.91404177D-15  -3.93547376D-15
   -1.37388553D-15   -6.88669813D-16  -3.05257405D-15  -3.62129407D-15  -3.91375792D-15  -3.93646828D-15  -4.57441915D-14
   -8.59973743D-16   -2.90483004D-15  -3.61240782D-15  -3.91261548D-15  -3.93644610D-15  -4.57339845D-14  -5.37800861D-14
   -2.39361596D-15   -3.56818421D-15  -3.90792474D-15  -3.93635302D-15  -4.56931666D-14  -5.37781217D-14
   -3.27454215D-15   -3.88669095D-15  -3.93590882D-15  -4.55300541D-14  -5.37702262D-14
   -3.73365375D-15   -3.93283271D-15  -4.48801456D-14  -5.37380380D-14
   -3.88303797D-15   -4.23209385D-14  -5.35996335D-14
   -3.27114634D-14   -5.28947150D-14
   -4.78489021D-14


          D( 0)

    0.0               0.0              0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0              0.0
    0.0               0.0              0.0              0.0
    0.0               0.0              0.0
    0.0               0.0
    0.0


          D( 1)

   -2.08191779D-14   -6.93972597D-15   2.23402144D 00   1.99483342D 00   2.00002583D 00   1.99999997D 00   2.00000000D 00
   -1.04095889D-14    2.09439510D 00   1.99857073D 00   2.00000555D 00   1.99999999D 00   2.00000000D 00   2.00000000D 00
    1.57079633D 00    2.00455975D 00   1.99998313D 00   2.00000002D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.89611890D 00    2.00026917D 00   1.99999975D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.97423160D 00    2.00001659D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.99357034D 00    2.00000103D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.99839336D 00    2.00000006D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.99959839D 00    2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.99989960D 00    2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.99997490D 00    2.00000000D 00   2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.99999373D 00    2.00000000D 00   2.00000000D 00   2.00000000D 00
    1.99999843D 00    2.00000000D 00   2.00000000D 00
    1.99999961D 00    2.00000000D 00
    1.99999990D 00
```

F4 EQNS

Pages "302" and "303" describe a program for implementing the Gauss-Seidel method for solving a set of n simultaneous linear equations. The program listing is on page "304." Data and partial output is shown on page "305."

EXAMPLE 5.3

GAUSS-SEIDEL METHOD

Problem Statement

Write a program that implements the Gauss-Seidel method, described in Section 5.7, for solving the following system of n simultaneous linear equations:

$$\begin{aligned}
a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n &= a_{1,n+1}\\
a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n &= a_{2,n+1}\\
\vdots \qquad\qquad\qquad\qquad & \quad \vdots\\
a_{n1}x_1 + a_{n2}x_2 + \cdots + a_{nn}x_n &= a_{n,n+1},
\end{aligned} \tag{5.3.1}$$

in which the a_{ij} are constants.

Method of Solution

In order to reduce the number of divisions required in the calculations, the coefficients of (5.3.1) are first normalized by dividing all elements in row i by a_{ii}, $i = 1, 2, \ldots, n$, to produce an augmented coefficient matrix of the form

$$\begin{bmatrix}
1 & a'_{12} & a'_{13} & \cdots & a'_{1n} & a'_{1,n+1}\\
a'_{21} & 1 & a'_{23} & \cdots & a'_{2n} & a'_{2,n+1}\\
\vdots & & & & \vdots & \vdots\\
a'_{n1} & a'_{n2} & a'_{n3} & \cdots & 1 & a'_{n,n+1}
\end{bmatrix}, \tag{5.3.2}$$

where $a'_{ij} = a_{ij}/a_{ii}$.

In terms of this notation, the approximation to the solution vector after the kth iteration,

$$\mathbf{x}_k = [x_{1k}, x_{2k}, \ldots, x_{nk}]^t,$$

is modified by the algorithm

$$x_{i,k+1} = a'_{i,n+1} - \sum_{j=1}^{i-1} a'_{ij}x_{j,k+1} - \sum_{j=i+1}^{n} a'_{ij}x_{jk}, \qquad i = 1, 2, \ldots, n, \tag{5.3.3}$$

to produce the next approximation

$$\mathbf{x}_{k+1} = [x_{1,k+1}, x_{2,k+1}, \ldots, x_{n,k+1}]^t.$$

Since, in the Gauss-Seidel method, the new values $x_{i,k+1}$ replace the old values x_{ik} as soon as computed, the iteration subscript k can be omitted, and (5.3.3) becomes

$$x_i = a'_{i,n+1} - \sum_{\substack{j=1\\ j\neq i}}^{n} a'_{ij}x_j, \qquad i = 1, 2, \ldots, n, \tag{5.3.4}$$

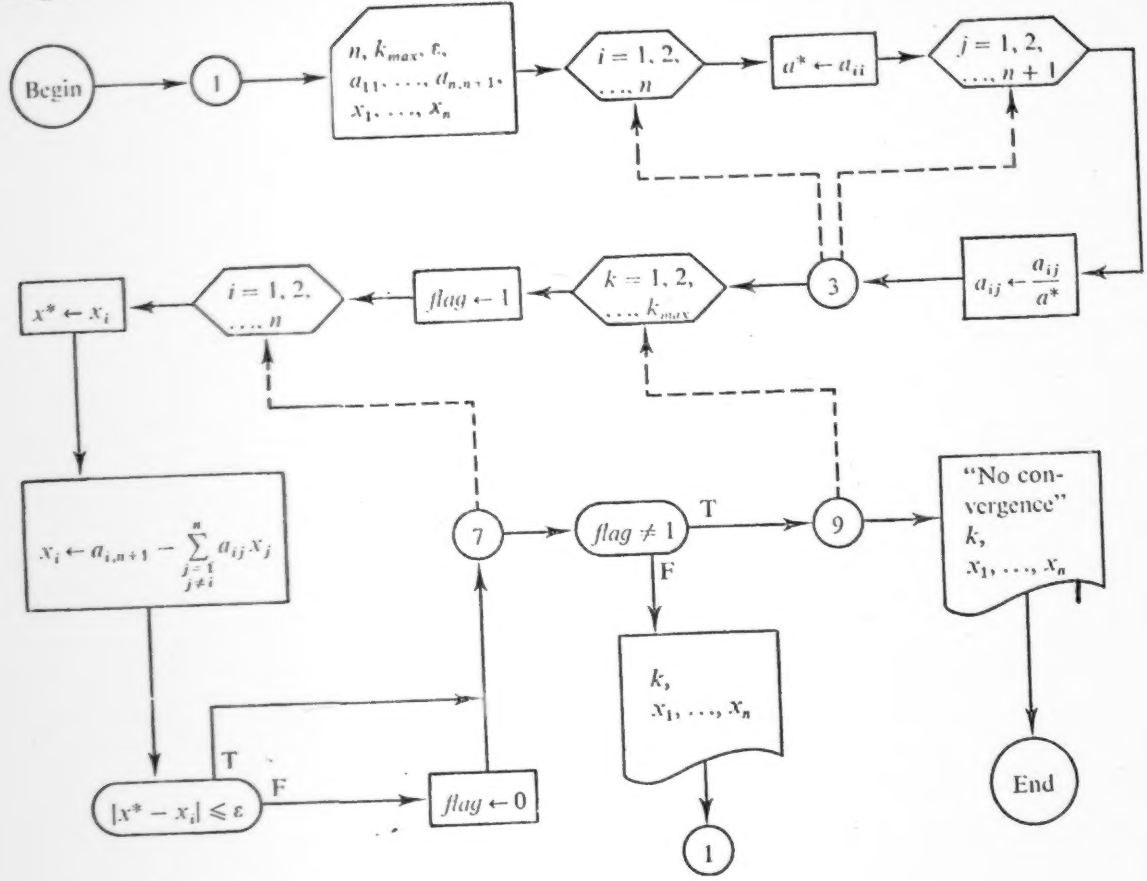
in which the most recently available x_j values are always used on the right-hand side. Hopefully, the x_i values computed by iterating with (5.3.4) will converge to the solution of (5.3.1).

The convergence criterion is

$$|x_{i,k+1} - x_{ik}| < \varepsilon, \qquad i = 1, 2, \ldots, n, \tag{5.3.5}$$

that is, no element of the solution vector may have its magnitude changed by an amount greater than ε as a result of one Gauss-Seidel iteration. Since convergence may not occur, an upper limit on the number of iterations, k_{max}, is also specified.

Flow Diagram


Begin
1
$n, k_{max}, \varepsilon,$
$a_{11}, \ldots, a_{n,n+1},$
$x_1, \ldots, x_n$
$i = 1, 2, \ldots, n$
$a^* \leftarrow a_{ii}$
$j = 1, 2, \ldots, n+1$
$a_{ij} \leftarrow \frac{a_{ij}}{a^*}$
3
$k = 1, 2, \ldots, k_{max}$
$flag \leftarrow 1$
$i = 1, 2, \ldots, n$
$x^* \leftarrow x_i$
$x_i \leftarrow a_{i,n+1} - \sum_{j=1, j\neq i}^{n} a_{ij}x_j$
$|x^* - x_i| \leqslant \varepsilon$
T
F
$flag \leftarrow 0$
7
$flag \neq 1$
T
F
9
"No convergence"
$k,$
$x_1, \ldots, x_n$
$k,$
$x_1, \ldots, x_n$
1
End

FORTRAN *Implementation*

List of Principal Variables

Program Symbol	*Definition*
A	$n \times (n+1)$ augmented coefficient matrix, containing elements a_{ij}.
ASTAR, XSTAR	Temporary storage locations for elements of A and X, respectively.
EPS	Tolerance used in convergence test, ε.
FLAG	A flag used in convergence testing; it has the value 1 for successful convergence, and the value 0 otherwise.
ITER	Iteration counter, k.
ITMAX	The maximum number of iterations allowed, k_{max}.
N	Number of simultaneous equations, n.
X	Vector containing the elements of the current approximation to the solution vector, $\mathbf{x}_k$.

Program Listing

```
C       APPLIED NUMERICAL METHODS, EXAMPLE 5.3
C       GAUSS-SEIDEL ITERATION FOR N SIMULTANEOUS LINEAR EQUATIONS.
C
C       THE ARRAY A CONTAINS THE N X N+1 AUGMENTED COEFFICIENT MATRIX.
C       THE VECTOR X CONTAINS THE LATEST APPROXIMATION TO THE SOLUTION.
C       THE COEFFICIENT MATRIX SHOULD BE DIAGONALLY DOMINANT AND
C       PREFERABLY POSITIVE DEFINITE.   ITMAX IS THE MAXIMUM NUMBER OF
C       ITERATIONS ALLOWED.   EPS IS USED IN CONVERGENCE TESTING.  IN
C       TERMINATING THE ITERATIONS, NO ELEMENT OF X MAY UNDERGO A MAG-
C       NITUDE CHANGE GREATER THAN EPS FROM ONE ITERATION TO THE NEXT.
C
      INTEGER FLAG
      DIMENSION A(20,20), X(20)
C
C     ..... READ AND CHECK INPUT PARAMETERS,
C           COEFFICIENT MATRIX, AND STARTING VECTOR .....
C
    1 READ (5,100) N, ITMAX, EPS
      WRITE (6,200) N, ITMAX, EPS
      NP1 = N + 1
      READ (5,101) ((A(I,J), J = 1, NP1), I = 1, N)
      READ (5,101) (X(I), I = 1, N)
      DO 2  I = 1, N
    2 WRITE (6,201) (A(I,J), J = 1, NP1)
      WRITE (6,202) (X(I), I = 1, N)
C
C     ..... NORMALIZE DIAGONAL ELEMENTS IN EACH ROW .....
      DO 3  I = 1, N
      ASTAR = A(I,I)
      DO 3  J = 1, NP1
    3 A(I,J) = A(I,J)/ASTAR
C
C     ..... BEGIN GAUSS-SEIDEL ITERATIONS .....
      DO 9  ITER = 1, ITMAX
      FLAG = 1
      DO 7  I = 1, N
      XSTAR = X(I)
      X(I) = A(I,NP1)
C
C     ..... FIND NEW SOLUTION VALUE, X(I) .....
      DO 5  J = 1, N
      IF (I .EQ. J) GO TO 5
         X(I) = X(I) - A(I,J)*X(J)
    5 CONTINUE
C
C     ..... TEST X(I) FOR CONVERGENCE .....
      IF (ABS(XSTAR - X(I)) .LE. EPS) GO TO 7
         FLAG = 0
    7 CONTINUE
      IF (FLAG .NE. 1) GO TO 9
         WRITE (6,203) ITER, (X(I), I = 1, N)
         GO TO 1
    9 CONTINUE
C
C     ..... REMARK IF METHOD DID NOT CONVERGE .....
      WRITE (6,204) ITER, (X(I), I = 1, N)
      GO TO 1
C
C     ..... FORMATS FOR INPUT AND OUTPUT STATEMENTS .....
  100 FORMAT (6X, I4, 16X, I4, 14X, F10.6)
  101 FORMAT (10X, 6F10.5)
  200 FORMAT (72H1 SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS BY GAUSS-SE
     1IDEL METHOD, WITH          /1H0, 5X, 9HN        = , I4/
     2 6X, 9HITMAX    = , I4/ 6X, 9HEPS      = , F10.5/ 47H0 THE COEFFICIENT
     3 MATRIX A(1,1)...A(N+1,N+1) IS)
  201 FORMAT (1H0, 11F10.5)
  202 FORMAT (36H0 THE STARTING VECTOR X(1)...X(N) IS/ (1H0, 10F10.5))
  203 FORMAT (35H0 PROCEDURE CONVERGED, WITH ITER = , I4/
     1 32H0 SOLUTION VECTOR X(1)...X(N) IS/ (1H0, 10F10.5))
  204 FORMAT (16H0 NO CONVERGENCE/ 10H0 ITER    = , I4/
     1 31H0 CURRENT VECTOR X(1)...X(N) IS/ (1H0, 10F10.5))
C
      END
```

Program Listing (*Continued*)

Data

```
N  =   4          ITMAX  =  15      EPS       =  0.0001
A(1,1) =   5.0         1.0        3.0        0.0        16.0        1.0
           4.0         1.0        1.0       11.0        -1.0        2.0
           6.0        -2.0       23.0        1.0        -1.0        1.0
           4.0        -2.0
X(1)   =   1.0         2.0        3.0        4.0
N  =   4          ITMAX  =  15      EPS       =  0.0001
A(1,1) =   5.0         1.0        3.0        0.0        16.0        1.0
           4.0         1.0        1.0       11.0        -1.0        2.0
           6.0        -2.0       23.0        1.0        -1.0        1.0
           4.0        -2.0
X(1)   =  50.0        50.0       50.0       50.0
N  =   6          ITMAX  =  50      EPS       =  0.0001
A(1,1) =   4.0        -1.0        0.0       -1.0         0.0        0.0
         100.0        -1.0        4.0       -1.0         0.0       -1.0
           0.0         0.0        0.0       -1.0         4.0        0.0
           0.0        -1.0        0.0       -1.0         0.0        0.0
           4.0        -1.0        0.0      100.0         0.0       -1.0
           0.0        -1.0        4.0       -1.0         0.0        0.0
           0.0        -1.0        0.0       -1.0         4.0        0.0
X(1)   =   0.0         0.0        0.0        0.0         0.0        0.0
```

Computer Output

Results for the 1st Data Set

```
SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS BY GAUSS-SEIDEL METHOD, WITH

    N       =    4
    ITMAX   =    15
    EPS     =    0.00010

THE COEFFICIENT MATRIX A(1,1)...A(N+1,N+1) IS

  5.00000   1.00000   3.00000   0.0       16.00000

  1.00000   4.00000   1.00000   1.00000   11.00000

 -1.00000   2.00000   6.00000  -2.00000   23.00000

  1.00000  -1.00000   1.00000   4.00000   -2.00000

THE STARTING VECTOR X(1)...X(N) IS

  1.00000   2.00000   3.00000   4.00000

PROCEDURE CONVERGED, WITH ITER =   12

SOLUTION VECTOR X(1)...X(N) IS

  0.99998   2.00000   2.99999  -0.99999
```

Partial Results for the 2nd Data Set (Same Equations as 1st Set)

```
THE STARTING VECTOR X(1)...X(N) IS

 50.00000  50.00000  50.00000  50.00000

PROCEDURE CONVERGED, WITH ITER =   13

SOLUTION VECTOR X(1)...X(N) IS

  1.00002   2.00000   3.00001  -1.00001
```

F5 COMPLEX

This program exercises complex arithmetic and double precision features of FORTRAN by calculating:

$$\exp\ (iz) = \sum_{k=o}^{n} (iz)^{k}/k!$$

for several values of z=x+iy and n.

Variables:

Integer - NTERM=n-delimits the number of terms used to obtain the estimate
NARG - the number of z values used

Complex arrays ARG - z values
EXPIZE - estimates of exp (iz)
EXPIZL - library function values of exp (iz)
EULIZ - values of exp (-y) (cos x+isinx)
SQRTEZ - values of [exp(iz)] 1/2
LGEXIZ - values of LOG [exp(iz)]

Double precision arrays - EXPYL - library function values of exp (-y)
EXPYE estimates of exp (-y)

```
F5 CØMPLEX

DIMENSIØN ARG(30), EXPIZE(30), EXPZL(30), EULIZ(30), SQRTEZ(30)
DIMENSIØN LGEXIZ(30), EXPYE(30), EXPY(30)
CØMPLEX Z, CSUM, CTERM, ARG, EXPIZE, EXPEL, EULIZ, SQRTEZ, LGEXIZ
DØUBLE PRECISION Y, SUM, TERM, EXPYE, EXPYL
READ 800 NTERM, NARG, (ARG (I), I=1, NARG)
DO 20 J=1, NARG
TERM=1.
SUM =0.
CTERM = (1,0)
CSUM = (1,0)
Z = ARG(J)
Y = AIMAG(Z)
DO 10 I = 1, NTERM
TERM = TERM*Y/FLØAT(I)
SUM = SUM + TERM
CTERM = CTERM*Z/FLØAT(I)
10 CSUM = CSUM + STERM
EXPIZE(J) = CSUM
EXPIZL(J) = CLØG( (0,1)*Z)
SQRTEZ(J) = CSQRT(EXPIZL(J) )
LGEXIZ(J) = CLØG(EXPIZL(J) )
```

```
EXPYE(J) = SUM
EXPYL(J) = DEXP(-Y)
20 EULIZ(J) = EXPYE(J)*(CØS(REAL(Z)) + (0,1)*SIN(REAL(Z))
WRITE 900 NTERM, NARG
900 FØRMAT(10H N TERMS = I10,20X 8H N ARG = I10)
WRITE 901 (ARG(I), EXPIZE (I), EXPIZL (I), I = 1, NARG)
WRITE 901 (EULIZ(I), SQRTEZ(I), LGEXIZ(I), I = 1, NARG)
901 FØRMAT (/ (6E20.14))
WRITE 902 (ARG(I), EXPYE(I), EXPYL(I), I = 1, NARG)
902 FØRMAT (/(2E20.14, 2D40.30))
800 FØRMAT (2I10)
END
```

COBOL PROGRAMS

INTRODUCTION

Source decks, test data and IBM job control cards are provided. The benchmark has been run on a 32K 360 Model 22.

The sequence for running these programs is as follows:

1. Load the file. C2 loads the file. Data, C6, must be preceded by a new file card. "New file" is punched in columns 1-7. Data cards must be in student number order, columns 1-5.
2. Update the file. C2 adds new records to the file, omit the new file card. Data, C7, is in random order, please do not sort.
3. Print the file. Two passes are made over the entire file printing selected records.
4. Copy the Index Sequential File to a sequential file using C4, then sort on position 92 major and positions 8-30 minor.

C1 FILE

This program is designed to aid in evaluation of raw file processing capability. A file of 10,000 records of 100 characters each should be generated for use with this program. Files should be blocked 10 records per block.

```
IDENTIFICATIØN DIVISIØN.
PRØGRAM-ID.  FILE-PRØCESSING.
AUTHØR.  LAWRENCE-MCNITT.
ENVIRØNMENT DIVISIØN.
CØNFIGURATIØN SECTIØN.
SØURCE-CØMPUTER.  ZZZ999.
ØBJECT-CØMPUTER.  ZZZ999.
INPUT-ØUTPUT SECTIØN.
FILE-CØNTRØL.  SELECT IN-FILE ASSIGN TØ DISK-1.
     SELECT ØU-FILE ASSIGN TØ DISK-2.
     SELECT PR-FILE ASSIGN TØ PRINTER.
DATA DIVISIØN.
FILE SECTIØN.
FD IN-FILE DATA RECØRD IN-RCD LABEL RECØRD ØMITTED
     BLØCK CØNTAINS 1000 CHARACTERS.
01   IN-RCD.
     02  IN1 PICTURE X(20)
     02  IN2.
         03 INV PICTURE 9(10) ØCCURS 8 TIMES.
FD   ØU-FILE DATA RECØRD ØU-RCD LABEL RECØRD ØMITTED
     BLØCK CØNTAINS 1000 CHARACTERS.
```

```
01    ØU-RCD.
      02 ØU1 PICTURE X(20).
      02 ØU2.
         03 ØUV PICTURE 9(10) ØCCURS 8 TIMES.
FD    PR-FILE DATA RECØRD PR-RCD LABEL RECØRD ØMITTED.
01    PR-RCD PICTURE X (132)
WØRKING-STØRAGE SECTIØN.
01    START-RCD.
      02  START1 PICTURE X(5) VALUE 'START'.
      02  START2 PICTURE X(127) VALUE SPACES.
01    STØP-RCD.
      02  STØP1 PICTURE X(4) VALUE 'STØP'.
      02  STØP2 PICTURE X(128) VALUE SPACES.
77    I PICTURE 99.
PRØCEDURE DIVISIØN.
PAR1. ØPEN INPUT IN-FILE ØUTPUT ØU-FILE, PR-FILE.
      WRITE PR-RCD FRØM START-RCD.
PAR2.  READ IN-FILE AT END GØ TØ PAR3
      MØVE IN1 TØ ØU1.
      PERFØRM PAR4 VARYING I FRØM 1 BY 1 UNTIL
          I GREATER THAN 8.
      WRITE ØU-RCD.
      GØ TØ PAR2.
PAR3.  WRITE PR-RCD FRØM STØP-RCD.
      CLØSE IN-FILE, ØU-FILE, PR-FILE.
      STØP RUN.
PAR4.  MØVE INV (I) TØ ØUV(I).
```

C2 CREATE UPDATE

This program will load or update an index sequential file from cards.

```
// JOB AC 00000          C2   CREATES AND UPDATES AN INDEX SEQ FILE
// OPTION CATAL
// PHASE C2,S
// EXEC COBOL
001010 IDENTIFICATION DIVISION.                                         SR1010
       PROGRAM-ID 'C2'.
001030 AUTHOR. J. GARBER.                                               SR1010
001040 REMARKS.  CREATES A NEW FILE IF DATA IF PRECEDED BY A            SR1010
001050           'NEWFILE' CARD.                                        SR1010
001060           REVISED FOR 360 BY DON E.                              SR1010
001070           BENCHMARK VERSION OF SR1010.
001090 DATE-WRITTEN. APRIL 26, 1970.                                    SR1010
001100 ENVIRONMENT DIVISION.                                            SR1010
001110 INPUT-OUTPUT SECTION.                                            SR1010
001120 FILE-CONTROL.                                                    SR1010
001130     SELECT RDR ASSIGN TO 'SYS004' UNIT-RECORD 1442R UNIT.        SR1010
001140     SELECT PRNTR ASSIGN TO 'SYS005' UNIT-RECORD 1403 UNIT.       SR1010
001150     SELECT STUDENT-FILE ASSIGN TO 'SYS052' DIRECT-ACCESS 2311    SR1010
001160         ACCESS IS RANDOM                                         SR1010
001170         ORGANIZATION IS INDEXED                                  SR1010
001180         SYMBOLIC KEY IS SYMBOLIC-ID-S                            SR1010
001190         RECORD KEY IS ID-UPDATE.                                 SR1010
001200     SELECT NEW-FILE ASSIGN TO 'SYS009' DIRECT-ACCESS 2311 UNIT   SR1010
002010         ACCESS IS SEQUENTIAL                                     SR1010
002020         ORGANIZATION IS INDEXED                                  SR1010
002030         RECORD KEY IS ID-NEW.                                    SR1010
002040 I-O-CONTROL.                                                     SR1010
002050     APPLY CORE-INDEX TO CYLNDX ON STUDENT-FILE.                  SR1010
002060 DATA DIVISION.                                                   SR1010
002070 FILE SECTION.                                                    SR1010
002080 FD  RDR                                                          SR1010
002090     RECORDING MODE IS F                                          SR1010
002100     LABEL RECORD IS OMITTED                                      SR1010
002110     DATA RECORD IS CHG-CRD.                                      SR1010
002120 01  CHG-CRD.                                                     SR1010
002130     02  ID-C1  PICTURE 99999.                                    SR1010
002140     02  ID-DIV-C1  PICTURE 9.                                    SR1010
002150     02  NAME-C1  PICTURE X(22).                                  SR1010
002160     02  C--DATA REDEFINES NAME-C1.                               SR1010
002170         03  SCHOOL-CODE-C1  PICTURE X.                           SR1010
002180         03  GPA-POINTS-C1  PICTURE 999V99.                       SR1010
002190         03  GPA-HOURS-C1   PICTURE 999V99.                       SR1010
002200         03  TOT-HRS  PICTURE 999V99.                             SR1010
003010         03  S-HRS  PICTURE 99V9.                                 SR1010
003020         03  D-1ST-ENROLLED-C1  PICTURE 999.                      SR1010
003030     02  D-OF-GRADUATION-C1  PICTURE 999.                         SR1010
003040     02 FILLER PICTURE X.                                         SR1010
003050     02  SEX-C2                 PICTURE X.                        SR1010
003060     02  MARITAL-STATUS-C2      PICTURE X.                        SR1010
003070     02  BIRTHDATE-C3.                                            SR1010
003080     03  CLASS-STANDING-C2      PICTURE XX.                       SR1010
003090     03  BIRTHDATE-C2  PICTURE 9999.                              SR1010
003100     03  BIR REDEFINES BIRTHDATE-C2.                              SR1010
003110         04  MO-C2              PICTURE XX.                       SR1010
003120         04  YR-C2              PICTURE XX.                       SR1010
003130     02  BIRTH-D REDEFINES BIRTHDATE-C3  PICTURE 999999:          SR1010
```

```
003140      02  STATE-COUNTRY-C2     PICTURE XXX.                          SP1010
003150      02  COUNTY-C2.                                                 SR1010
003160      03  VISA-C3              PICTURE X.                            SP1010
003170      03 FILLER PICTURE X.                                           SR1010
003180      02  VISA-C2              PICTURE X.                            SP1010
003190      02  CONFERENCE-C2        PICTURE XX.                           SP1010
003200      02  ADMISSION-STATUS-C2 PICTURE X.                             SP1010
004010      02  SECONDARY-SCHOOL-C2 PICTURE XX.                            SR1010
004020      02  DEGREE-COLLEGE-C2   PICTURE 9.                             SP1010
004030      02  COURSE-OF-STUDY-C2  PICTURE XX.                            SP1010
004040      02  MAJOR-OR-DEGREE-C2  PICTURE XX.                            SR1010
004050      02  FILLER  PICTURE XXXX.                                      SP1010
004060      02  ADVISOR-C2  PICTURE XX.                                    SR1010
004070      02  ENTRANCE-STATUS-C2  PICTURE X.                             SP1010
004080      02  HS-GPA-C2               PICTURE 9V99.                      SP1010
004090      02  LOAD-C                  PICTURE 99V9.                      SP1010
004100      02  RESIDENCE-STATUS-C2 PICTURE X.                             SP1010
004110      02  SOCIAL-STATUS-C2    PICTURE X.                             SP1010
004120      02  ENTRANCE-STATUS-C3  PICTURE X.                             SP1010
004130      02  ETHNIC-ORIGIN-C2 REDEFINES ENTRANCE-STATUS-C3 PICTURE X.  SP1010
004140      02  WITHDRAWAL-DATE-C2  PICTURE 9999.                          SP1010
004150      02  W-D-C  REDEFINES WITHDRAWAL-DATE-C2.                       SR1010
004160      03  LOAD-G            PICTURE 99V9.                            SR1010
004170      03 FILLER PICTURE X.                                           SR1010
004180      02  QTR-C2  PICTURE 9.                                         SR1010
004190      02  YEAR-C2  PICTURE 99.                                       SR1010
004200      02  CRD-CODE                PICTURE X.                         SR1010
005010 FD  STUDENT-FILE                                                    SP1010
005020     RECORDING MODE F                                                SP1010
005030     LABEL RECORD IS STANDARD                                        SP1010
005040     BLOCK CONTAINS 5 RECORDS                                        SR1010
005050     RECORD CONTAINS 155 CHARACTERS                                  SR1010
005060     DATA RECORD IS UPDATE-REC.                                      SP1010
005070 01  UPDATE-REC.                                                     SR1010
005080      02  FILLER  PICTURE X.                                         SP1010
005090      02  ID-UPDATE  PICTURE 99999.                                  SR1010
005100      02  FILLER  PICTURE X(149).                                    SR1010
005110 FD  NEW-FILE                                                        SP1010
005120     RECORDING MODE F                                                SP1010
005130     LABEL RECORD STANDARD                                           SR1010
005140     BLOCK CONTAINS 5 RECORDS                                        SR1010
005150     RECORD CONTAINS 155 CHARACTERS                                  SP1010
005160     DATA RECORD IS NEW-REC.                                         SR1010
005170 01  NEW-REC.                                                        SP1010
005180      02  FILLER  PICTURE X.                                         SR1010
005190      02  ID-NEW  PICTURE 99999.                                     SP1010
005200      02  FILLER  PICTURE X(149).                                    SP1010
006010 FD PRNTR COPY 'PRNTR'.                                              SR1010
006020 WORKING-STORAGE SECTION.                                            SP1010
006030 77  CYLNDX  PICTURE X(1000).                                        SR1010
006040 77  SYMBOLIC-ID-S  PICTURE 99999.                                   SR1010
006050 01  INVALID-LINE.                                                   SP1010
006060      02  CARD-IMAGE.                                                SR1010
006070          03 MSG-11 PICTURE X(27).                                   SP1010
006080          03 FILLER PICTURE X(53).                                   SR1010
006090      02  FILLER  PICTURE X(7) VALUE SPACES.                         SP1010
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006100      02  MSG  PICTURE X(25).                                       SR1010
006110      02  FILLER  PICTURE X(20) VALUE SPACES.                       SR1010
006120 01   HD-1.                                                         SR1010
006130      02  FILLER  PICTURE X(24)  VALUE 'STUDENT FILE MAINTENANCE'.  SR1010
006140      02  FILLER  PICTURE X(100) VALUE SPACES.                      SR1010
006150       02 FILLER.                                                   SR1010
006160      03  FILLER  PICTURE X(5)   VALUE 'PAGE '.                     SR1010
006170      03  PAG-NO  PICTURE ZZZ.                                      SR1010
006180 01   HD-2.                                                         SR1010
006190      02  DATE-P  PICTURE X(8).                                     SR1010
006200      02  FILLER  PICTURE X(124) VALUE SPACES.                      SR1010
007010 01   HD-3.                                                         SR1010
007020      02  FILLER PICTURE X(27) VALUE '       SCH MAR  BIRTH  STE '. SR1010
007030      02  FILLER PICTURE X(27) VALUE '   VISA  ADM  COL COL CRS M'. SR1010
007040      02  FILLER PICTURE X(27) VALUE 'AJ ENT HS RES REL DATE  ENR'. SR1010
007050      02  FILLER PICTURE X(27) VALUE 'L GRAD HONOR  GPA  TOTAL  S'. SR1010
007060      02  FILLER PICTURE X(24) VALUE 'AT ACT GRE              '.    SR1010
007070 01   HD-4.                                                         SR1010
007080      02  FILLER PICTURE X(27) VALUE '  ID    SEX CLAS       CTRY '. SR1010
007090      02  FILLER PICTURE X(27) VALUE 'CNTY  CONF  HS    DEG STY D'. SR1010
007100      02  FILLER PICTURE X(27) VALUE 'EG     GPA  SOC  WITHDR DAT'. SR1010
007110      02  FILLER PICTURE X(27) VALUE 'E DATE  PTS  HRS   HRS    H'. SR1010
007120      02  FILLER PICTURE X(24) VALUE 'RS ORIG                 '.    SR1010
       01   STUDENT-RECORD.
            02  DELETE-S  PICTURE X.
            02  ID-S  PICTURE 9(5).
            02  DIV-S  PICTURE 9.
            02  NAME  PICTURE X(23).
            02  SEX-S  PICTURE X.
            02  MARITAL-STATUS-S  PICTURE X.
            02  CLASS-STANDING-S  PICTURE XX.
            02  BIRTHDATE-S  PICTURE 9(7) COMPUTATIONAL-3.
            02  STATE-COUNTRY-S  PICTURE XXX.
            02  COUNTY-S  PICTURE XX.
            02  VISA-S  PICTURE X.
            02  CONFERENCE-S  PICTURE XX.
            02  ADMISSION-STATUS-S  PICTURE X.
            02  SECONDARY-SCHOOL-S  PICTURE XX.
            02  COLLEGE-S  PICTURE XX.
            02  DEGREE-COLLEGE-S  PICTURE X.
            02  FILLER  PICTURE X.
            02  COURSE-OF-STUDY-S  PICTURE XX.
            02  MAJOR-OF-DEGREE-S  PICTURE XX.
            02  ENTRANCE-STATUS-S  PICTURE X.
            02  HS-GPA-S  PICTURE 9V99 COMPUTATIONAL-3.
            02  HR-ACCUMS  COMPUTATIONAL-3.
                03  FALL-HR  PICTURE 99V9.
                03  WINTER-HR  PICTURE 99V9.
                03  SPRING-HR  PICTURE 99V9.
                03  SUMMER-HR  PICTURE 99V9.
                03  COLL-HR  PICTURE 99V9.
                03  GRAD-HR  PICTURE 99V9.
                03  SEM-HR  PICTURE 99V9.
            02  HRS-REDEFINED REDEFINES HR-ACCUMS COMPUTATIONAL-3.
                03  HR-ACCUM-S   PICTURE 99V9 OCCURS 7 TIMES.
            02  RESIDENCE-STATUS-S  PICTURE X.
            02  SOCIAL-STATUS-S  PICTURE X.
            02  WITHDRAWAL-DATE-S  PICTURE 99999 COMPUTATIONAL-3.
            02  GPA-DATA  COMPUTATIONAL-3.
                03  GPA-POINTS-S  PICTURE 999V99.
                03  GPA-HOURS-S  PICTURE 999V99.
                03  TOT-HOURS-S  PICTURE 999V99.
                03  SAT-HOURS-S  PICTURE 999V99.
            02  SCHOOL-CODES.
                03  SCH-CODE-S  PICTURE X OCCURS 4 TIMES.
            02  RELIGION-S  PICTURE X.
            02  ENTRANCE-DATE-S  PICTURE 999 COMPUTATIONAL-3.
            02  GRADUATION-DATE-S  PICTURE 999 COMPUTATIONAL-3.
            02  GPA-DATA-BY-QTR  COMPUTATIONAL-3.
                03  GPA-Q  PICTURE 9V99.
                03  CLASS-STANDING-Q  PICTURE  999.
            02  FILE-DATE.
                03  YEAR-S  PICTURE 99.
                03  QTR-S  PICTURE 9.
            02  ADVISOR-S  PICTURE XX.
            02  PHONE-S  PICTURE S9(11) COMPUTATIONAL-3.
            02  STATISTICS-STATUS-S.
                03  STAT-STATUS-S  PICTURE X OCCURS 4 TIMES.
            02  ETHNIC-ORIGIN  PICTURE X.
            02  FILLER           PICTURE X(23).
            02  SORT-S  PICTURE X(12).
007140 01   DTL-LINE.                                                      SR1010
007150      02  FLD1                PICTURE X(5).                          SR1010
007160      02  FLD2                PICTURE X.                             SR1010
007170      02  FILLER         PICTURE X.                                  SR1010
007180      02  FLD3                PICTURE X.                             SR1010
007190      02  FILLER         PICTURE X.                                  SR1010
007200      02  FLD4                PICTURE X.                             SR1010
008010      02  FILLER         PICTURE X.                                  SR1010
008020      02  FLD5                PICTURE X.                             SR1010
008030      02  FILLER         PICTURE X.                                  SR1010
008040      02  FLD6                PICTURE XX.                            SR1010
008050      02  FLD7  PICTURE Z999999.                                     SR1010
008060      02  FILLER         PICTURE X.                                  SR1010
008070      02  FLD8                PICTURE XXX.                           SR1010
008080      02  FILLER              PICTURE XX.                            SR1010
008090      02  FLD9                PICTURE XX.                            SR1010
008100      02  FILLER         PICTURE XX.                                 SR1010
008110      02  FLD10               PICTURE X.                             SR1010
008120      02  FILLER         PICTURE X.                                  SR1010
008130      02  FLD11               PICTURE XX.                            SR1010
008140      02  FILLER         PICTURE X.                                  SR1010
008150      02  FLD12               PICTURE X.                             SR1010
008160      02  FILLER         PICTURE X.                                  SR1010
008170      02  FLD13               PICTURE XX.                            SR1010
008180      02  FILLER         PICTURE X.                                  SR1010
008190      02  FLD14               PICTURE XX.                            SR1010
008200      02  FILLER  .                                                  SR1010
009010      03  FILLER              PICTURE XX.                            SR1010
009020      03  FLD15  PICTURE XX.                                         SR1010
009030      02  FILLER              PICTURE XX.                            SR1010
009040      02  FLD16               PICTURE XX.                            SR1010
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009050      02  FILLER               PICTURE XX.                             SR1010
009060      02  FLD17                       PICTURE XX.                      SR1010
009070      02  FILLER               PICTURE XX.                             SR1010
009080      02  FLD18                       PICTURE X.                       SR1010
009090       02 FILLER.                                                      SR1010
009100      03  FILLER               PICTURE X.                              SR1010
009110      03  FLD19                       PICTURE 9.99.                    SR1010
009120      02  FILLER               PICTURE X.                              SR1010
009130      02  FLD20                       PICTURE X.                       SR1010
009140      02  FILLER               PICTURE X.                              SR1010
009150      02  FLD21                       PICTURE X.                       SR1010
009160      02  FILLER               PICTURE X.                              SR1010
009170      02  FLD22                       PICTURE X.                       SR1010
009180      02  FILLER  PICTURE X.                                           SR1010
009190      02  FLD23  PICTURE Z9999.                                        SR1010
009200       02 FILLER.                                                      SR1010
010010      03  FILLER                PICTURE XX.                            SR1010
010020      03  FLD24                       PICTURE 9989.                    SR1010
010030      03  FILLER               PICTURE X.                              SR1010
010040      03  FLD25                       PICTURE 9989.                    SR1010
010050      03  FILLER                      PICTURE X.                       SR1010
010060      03  FLD26                       PICTURE ZZZ.ZZ.                  SR1010
010070      03  FLD27                       PICTURE ZZZ.ZZ.                  SR1010
010080      03  TOT-HRS-P        PICTURE  ZZZ.ZZ.                            SR1010
010090      03  S-HRS-P  PICTURE ZZZ.ZZ.                                     SR1010
010100      02  FILLER               PICTURE X.                              SR1010
010110      02  FLD28                PICTURE X.                              SR1010
010120      02  FILLER  PICTURE X.                                           SR1010
010130      02  NAME-P               PICTURE X(17).                          SR1010
010150 01   FILLER.                                                          SR1010
011040      02  LINE-CNT PICTURE 999 COMPUTATIONAL-3 VALUE 0.                SR1010
011050      02  PAG-CTR  PICTURE 999 COMPUTATIONAL-3 VALUE 0.                S 1010
011060      02  RDR-END-SW  PICTURE X VALUE '0'.                              1010
011070      02  RE-WRITE-SW  PICTURE X VALUE '0'.                            SR1010
011080      02  NO-FIND  PICTURE X VALUE '0'.                                SR1010
011090      02  SCHOOL-CODE-X  PICTURE X VALUE ' '.                          SR1010
011100      02  NEWFILE-SW  PICTURE X VALUE ' '.                             SR1010
011110 PROCEDURE DIVISION.                                                   SR1010
011120 OPEN-RT.                                                              SR1010
011130      MOVE SPACES TO DTL-LINE.                                         SR1010
011140      DISPLAY 'AC1010 NOW RUNNING' UPON CONSOLE.
011150      OPEN INPUT RDR OUTPUT PRNTR.                                     SR1010
011155      NOTE    ------- GETDATE PUTS TODAYS DATE IN DATE-P --------.
011160      ENTER LINKAGE.                                                   SR1010
011170      CALL 'GETDATE' USING DATE-P.
011180      ENTER COBOL.                                                     SR1010
012090      PERFORM PAG-HD.                                                  SR1010
012090 READ-CARDS.                                                           SR1010
012100      READ RDR AT END MOVE '1' TO RDR-END-SW.                          SR1010
012110 ONWARD.                                                               SR1010
012120      IF ID-C1 = 'NEWFI' GO TO LOAD-FILE.                              SR1010
012130      OPEN I-O STUDENT-FILE.                                           SR1010
012140      GO TO SKIP-READ.                                                 SR1010
012150 READ-RT.                                                              SR1010
012160      PERFORM READ-CARDS.                                              SR1010
012170 SKIP-READ.                                                            SR1010
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012180     IF RDR-END-SW = '1' GO TO EOJ.                                   SR1010
012190     IF LINE-CNT GREATER THAN 55 PERFORM PAG-HD.                      SR1010
013030     MOVE '0' TO RE-WRITE-SW.                                         SR1010
013040     PERFORM RANDOM-READ.                                             SR1010
013050     IF CRD-CODE = 'J' GO TO DELETE-RT.                               SR1010
013060     IF NO-FIND = '1' PERFORM ADD-RT THRU ADD-EXIT, GO TO             SR1010
013070         READ-RT.                                                     SR1010
013080     IF DELETE-S = '1' MOVE '1' TO RE-WRITE-SW, PERFORM ADD-RT        SR1010
013090         THRU ADD-EXIT, GO TO READ-RT.                                SR1010
013100     GO TO CHANGE-RT.                                                 SR1010
013110 DELETE-RT.                                                           SR1010
013120     IF NO-FIND = '1' MOVE 'DELETION, REC NOT FOUND' TO MSG,          SR1010
013130         PERFORM INVALID-CARD-RT, GO TO READ-RT.                      SR1010
013140     IF FALL-HR = 0 AND WINTER-HR = 0 AND SPRING-HR = 0               SR1010
013150         AND COLL-HR = 0 AND GRAD-HR = 0 AND SEM-HR = 0               SR1010
013160         NEXT SENTENCE  ELSE                                          SR1010
013170         MOVE 'CREDTS, DELETION REJECTED' TO MSG,                     SR1010
013180         PERFORM INVALID-CARD-RT, GO TO READ-RT.                      SR1010
013190     IF LINE-CNT , 55 PERFORM PAG-HD.                                 SR1010
013200     MOVE '0' TO CTL.                                                 SR1010
014010     MOVE 'FOLLOWING RECORD DELETED' TO BODY, PERFORM PRNT.           SR1010
014020     PERFORM PRINT-RT.                                                SR1010
014030     MOVE '1' TO DELETE-S.                                            SR1010
014040     PERFORM RE-WRITE.                                                SR1010
014050     GO TO READ-RT.                                                   SR1010
014060 CHANGE-RT.                                                           SR1010
014070     IF CRD-CODE = 'L' OR CRD-CODE = 'M' OR CRD-CODE = 'N'            SR1010
014080         OR CRD-CODE = 'P' OR CRD-CODE = '9' NEXT SENTENCE ELSE       SR1010
014090         MOVE 'BAD CHANGE CODE' TO MSG,                               SR1010
014100         PERFORM INVALID-CARD-RT, GO TO READ-RT.                      SR1010
014110     IF LINE-CNT , 55 PERFORM PAG-HD.                                 SR1010
014120     MOVE 'CHANGES---' TO BODY, MOVE '0' TO CTL, PERFORM PRNT.        SR1010
014130     PERFORM PRINT-RT.                                                SR1010
014140     IF CRD-CODE = 'L' OR CRD-CODE = 'M' GO TO CHANGE-COLLEGE.        SR1010
014150     IF CRD-CODE = 'N' GO TO CHANGE-GRAD-SEM.                         SR1010
014160     IF CRD-CODE = 'P' GO TO ORIGIN-DATA.                             SR1010
014170     IF ID-DIV-C1 NOT = ' '                                           SR1010
014180         MOVE ID-DIV-C1 TO DIV-S.                                     SR1010
014190     IF GPA-POINTS-C1 IS NUMERIC                                      SR1010
014200         ADD  GPA-POINTS-C1 TO GPA-POINTS-S.                          SR1010
015010     IF GPA-HOURS-C1 IS NUMERIC                                       SR1010
015020         ADD  GPA-HOURS-C1 TO GPA-HOURS-S.                            SR1010
015030     IF TOT-HRS IS NUMERIC ADD TOT-HRS TO TOT-HOURS-S.                SR1010
015040     IF S-HRS IS NUMERIC ADD S-HRS TO SAT-HOURS-S.                    SR1010
015050     IF D-1ST-ENROLLED-C1 IS NUMERIC                                  SR1010
015060         MOVE D-1ST-ENROLLED-C1 TO ENTRANCE-DATE-S.                   SR1010
015070     IF D-OF-GRADUATION-C1 IS NUMERIC                                 SR1010
015080         MOVE D-OF-GRADUATION-C1 TO GRADUATION-DATE-S.                SR1010
015090     GO TO IN-COL.                                                    SR1010
015100 CHANGE-COLLEGE.                                                      SR1010
015110     PERFORM COLLEGE-DATA.                                            SR1010
015120 IN-COL.                                                              SR1010
015130     PERFORM PRINT-RT.                                                SR1010
015140     PERFORM RE-WRITE.                                                SR1010
015150     GO TO READ-RT.                                                   SR1010
015160 COLLEGE-DATA.                                                        SR1010
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015170        IF NAME-C1 NOT = '                         ' MOVE NAME-C1       SR1010
015180            TO NAME .                                                   SR1010
015190        IF ID-DIV-C1 IS NUMERIC MOVE ID-DIV-C1 TO DIV-S.                SR1010
015200        IF SEX-C2 NOT = ' '                                             SR1010
016010            MOVE SEX-C2 TO SEX-S.                                       SR1010
016020        IF MARITAL-STATUS-C2 NOT = ' '                                  SR1010
016030            MOVE MARITAL-STATUS-C2 TO MARITAL-STATUS-S.                 SR1010
016040        IF CLASS-STANDING-C2 NOT = '  '                                 SR1010
016050            MOVE CLASS-STANDING-C2 TO CLASS-STANDING-S.                 SR1010
016060        IF BIRTHDATE-C2 IS NUMERIC                                      SR1010
016070            MOVE MO-C2 TO CLASS-STANDING-C2 MOVE 00 TO MO-C2            SR1010
016080            MOVE BIRTH-D TO BIRTHDATE-S.                                SR1010
016090        IF STATE-COUNTRY-C2 NOT = '   '                                 SR1010
016100            MOVE STATE-COUNTRY-C2 TO STATE-COUNTRY-S.                   SR1010
016110        IF COUNTY-C2 NOT = '  '                                         SR1010
016120            MOVE COUNTY-C2 TO COUNTY-S.                                 SR1010
016130        IF VISA-C2 NOT = ' '                                            SR1010
016140            MOVE VISA-C2 TO VISA-S.                                     SR1010
016150        IF CONFERENCE-C2 NOT = '  '                                     SR1010
016160            MOVE CONFERENCE-C2 TO CONFERENCE-S.                         SR1010
016170        IF ADMISSION-STATUS-C2 NOT = ' '                                SR1010
016180            MOVE ADMISSION-STATUS-C2 TO ADMISSION-STATUS-S.             SR1010
016190        IF SECONDARY-SCHOOL-C2 NOT = '   '                              SR1010
016200            MOVE SECONDARY-SCHOOL-C2 TO SECONDARY-SCHOOL-S.             SR1010
017010        IF DEGREE-COLLEGE-C2 NOT = ' '                                  SR1010
017020            MOVE DEGREE-COLLEGE-C2 TO DEGREE-COLLEGE-S.                 SR1010
017030        IF COURSE-OF-STUDY-C2 NOT = '  '                                SR1010
017040            MOVE COURSE-OF-STUDY-C2 TO COURSE-OF-STUDY-S.               SR1010
017050        IF MAJOR-OR-DEGREE-C2 NOT = '  '                                SR1010
017060            MOVE MAJOR-OR-DEGREE-C2 TO MAJOR-OR-DEGREE-S.               SR1010
017070        IF ADVISOR-C2 NOT = '  ' MOVE ADVISOR-C2 TO ADVISOR-S.          SR1010
017080        IF ENTRANCE-STATUS-C2 NOT = ' '                                 SR1010
017090            MOVE ENTRANCE-STATUS-C2 TO ENTRANCE-STATUS-S.               SR1010
017100        IF HS-GPA-C2 IS NUMERIC                                         SR1010
017110           MOVE HS-GPA-C2 TO HS-GPA-S.                                  SR1010
017120        IF RESIDENCE-STATUS-C2 NOT = ' '                                SR1010
017130            MOVE RESIDENCE-STATUS-C2 TO RESIDENCE-STATUS-S.             SR1010
017140        IF SOCIAL-STATUS-C2 NOT = ' '                                   SR1010
017150            MOVE SOCIAL-STATUS-C2 TO SOCIAL-STATUS-S.                   SR1010
017160        IF WITHDRAWAL-DATE-C2 IS NUMERIC                                SR1010
017170            MOVE WITHDRAWAL-DATE-C2 TO WITHDRAWAL-DATE-S.               SR1010
017180        IF CRD-CODE = 'L' MOVE '3' TO SCHOOL-CODE-X                     SR1010
017190             ELSE MOVE '4' TO SCHOOL-CODE-X.                            SR1010
017200        IF SCHOOL-CODE-X NOT = SCH-CODE-S (QTR-S) PERFORM SCHOOL-CHG,   SR1010
018010        MOVE SCHOOL-CODE-X TO SCH-CODE-S (QTR-S).
018020 CHANGE-GRAD-SEM.                                                       SR1010
018030        PERFORM GRAD-SEM-DATA THRU GRAD-SEM-EXIT.                       SR1010
018040        GO TO IN-COL.                                                   SR1010
018050 GRAD-SEM-DATA.                                                         SR1010
018060        IF NAME-C1 NOT = '                         ' MOVE NAME-C1       SR1010
018070            TO NAME .                                                   SR1010
018080        IF ID-DIV-C1 IS NUMERIC MOVE ID-DIV-C1 TO DIV-S.                SR1010
018090        IF SEX-C2 NOT = ' '                                             SR1010
018100            MOVE SEX-C2 TO SEX-S.                                       SR1010
018110        IF MARITAL-STATUS-C2 NOT = ' '                                  SR1010
018120            MOVE MARITAL-STATUS-C2 TO MARITAL-STATUS-S.                 SR1010
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018130      IF BIRTH-D IS NUMERIC MOVE BIRTH-D TO BIRTHDATE-S.               SR1010
018140      IF STATE-COUNTRY-C2 NOT = '    '                                 SR1010
018150          MOVE STATE-COUNTRY-C2 TO STATE-COUNTRY-S.                    SR1010
018160      IF VISA-C3 = ' '  GO TO CCK.                                     SR1010
018170          MOVE VISA-C3 TO VISA-S.                                      SR1010
018180      IF VISA-S = '3' MOVE '2' TO VISA-S GO TO CCK.                    SR1010
018190      IF VISA-S = '2' MOVE '3' TO VISA-S.                              SR1010
018200 CCK.                                                                  SR1010
019010      IF CONFERENCE-C2 NOT = '  ' MOVE CONFERENCE-C2 TO COLLEGE-S.     SR1010
019020      IF SECONDARY-SCHOOL-C2 NOT = '  ' MOVE                           SR1010
019030          SECONDARY-SCHOOL-C2 TO MAJOR-OR-DEGREE-S.                    SR1010
019040      IF DEGREE-COLLEGE-C2 NOT = ' ' MOVE                              SR1010
019050          DEGREE-COLLEGE-C2 TO RELIGION-S.                             SR1010
019060      IF COURSE-OF-STUDY-C2 NOT = '  ' MOVE COURSE-OF-STUDY-C2         SR1010
019070          TO CONFERENCE-S.                                             SR1010
019080      IF ENTRANCE-STATUS-C3 NOT = ' '                                  SR1010
019090          MOVE ENTRANCE-STATUS-C3 TO ENTRANCE-STATUS-S.                SR1010
019100      IF ADMISSION-STATUS-C2 = '1' MOVE '5' TO SCHOOL-CODE-X           SR1010
019110          GO TO A1.                                                    SR1010
019120      IF ADMISSION-STATUS-C2 = '2' MOVE '6' TO SCHOOL-CODE-X           SR1010
019130          GO TO A1.                                                    SR1010
019140      GO TO GRAD-SEM-EXIT.                                             SR1010
019150 A1.                                                                   SR1010
019160      IF SCH-CODE-S (QTR-S) = SCHOOL-CODE-X NEXT SENTENCE
019170      ELSE PERFORM SCHOOL-CHG MOVE SCHOOL-CODE-X TO SCH-CODE-S         SR1010
019180          (QTR-S).
019190 A2.                                                                   SR1010
019200 GRAD-SEM-EXIT. EXIT.                                                  SR1010
020010 ORIGIN-DATA.                                                          SR1010
020020      IF ETHNIC-ORIGIN-C2 NOT = ' '                                    SR1010
020030          MOVE ETHNIC-ORIGIN-C2 TO ETHNIC-ORIGIN.                      SR1010
020040      GO TO IN-COL.                                                    SR1010
020050 ADD-RT.                                                               SR1010
020060      PERFORM INIT-RECORD.                                             SR1010
020070      IF CRD-CODE = 'L' MOVE '3' TO SCH-CODE-S (QTR-S) GO TO           SR
020080          COLLEGE-ADD-RT.                                              SR1010
020090      IF CRD-CODE = 'M' MOVE '4' TO SCH-CODE-S (QTR-S) GO TO           SR1010
020100          COLLEGE-ADD-RT.                                              SR1010
020110      GO TO CRD-3.                                                     SR1010
020120 ADD-EXIT. EXIT.                                                       SR1010
020130 COLLEGE-ADD-RT.                                                       SR1010
020140      PERFORM COLLEGE-DATA.                                            SR1010
020150      IF LINE-CNT , 55 PERFORM PAG-HD.                                 SR1010
020160      MOVE '0' TO CTL.                                                 SR1010
020170      MOVE 'NEW RECORD' TO BODY, PERFORM PRNT.                         SR1010
020180      PERFORM PRINT-RT.                                                SR1010
020190      PERFORM WRITE-NEW THRU N-EXIT.                                   SR1010
020200      GO TO ADD-EXIT.                                                  SR1010
021010 CRD-3.                                                                SR1010
021020      IF CRD-CODE = 'N' NEXT SENTENCE                                  SR1010
021030          ELSE MOVE 'NO RECORD FOUND' TO MSG                           SR1010
021040      PERFORM INVALID-CARD-RT GO TO ADD-EXIT.                          SR1010
021050      IF ADMISSION-STATUS-C2 = '1' MOVE '5' TO SCH-CODE-S (QTR-S)      SR1010
021060          ELSE MOVE '6' TO SCH-CODE-S (QTR-S).
021070      PERFORM GRAD-SEM-DATA THRU GRAD-SEM-EXIT.                        SR1010
021080      IF LINE-CNT , 55 PERFORM PAG-HD.                                 SR1010
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021090      MOVE '0' TO CTL.                                                  SR1010
021100      MOVE 'NEW RECORD' TO BODY, PERFORM PRNT.                          SR1010
021110      PERFORM PRINT-RT.                                                 SR1010
021120      PERFORM WRITE-NEW THRU N-EXIT.                                    SR1010
021130      GO TO ADD-EXIT.                                                   SR1010
021140 INVALID-CARD-RT.                                                       SR1010
021150      MOVE CHG-CRD TO CARD-IMAGE.                                       SR1010
021160      MOVE INVALID-LINE TO BODY, MOVE '0' TO CTL, PERFORM PRNT.         SR1010
021170      MOVE '****************' TO MSG.                                   SR1010
021180 PAG-HD.                                                                SR1010
021190      MOVE  0 TO LINE-CNT.                                              SR1010
022070 PRINT-RT.                                                              SR1010
023080      MOVE SPACES TO DTL-LINE.                                          SR1010
023090 SCHOOL-CHG.                                                            SR1010
023100      PERFORM CHK-GPA THRU GPA-XT.                                      SR1010
023110      MOVE '*****NOTE SCHOOL CHANGE***' TO BODY, PERFORM PRNT.          SR1010
023120 CHK-GPA.                                                               SR1010
023130      IF SCHOOL-CODE-X = '5' AND SCH-CODE-S (QTR-S) = '6'
023140          GO TO GPA-XT.                                                 SR1010
023150      IF SCHOOL-CODE-X = '6' AND SCH-CODE-S (QTR-S) = '5'               SR1010
023160          GO TO GPA-XT.                                                 SR1010
023170      MOVE 0 TO GPA-POINTS-S.                                           SR1010
023180      MOVE 0 TO GPA-HOURS-S.                                            SR1010
023190      MOVE 0 TO GRADUATION-DATE-S.                                      SR1010
023200      MOVE 0 TO TOT-HOURS-S.                                            SR1010
024010      MOVE 0 TO SAT-HOURS-S.                                            SR1010
024020      MOVE 0 TO WITHDRAWAL-DATE-S.                                      SR1010
024030      MOVE  732          TO ENTRANCE-DATE-S.
024040 GPA-XT. EXIT.                                                          SR1010
024050 INIT-RECORD.                                                           SR1010
024060      MOVE SPACES TO STUDENT-RECORD.                                    SR1010
024070      MOVE 0 TO HS-GPA-S.                                               SR1010
024080      MOVE 0 TO BIRTHDATE-S.                                            SR1010
024090      MOVE 0 TO FALL-HR.                                                SR1010
024100      MOVE 0 TO WINTER-HR.                                              SR1010
024110      MOVE 0 TO SPRING-HR.                                              SR1010
024120      MOVE 0 TO SUMMER-HR.                                              SR1010
024130      MOVE 0 TO COLL-HR.                                                SR1010
024140      MOVE 0 TO GRAD-HR.                                                SR1010
024150      MOVE 0 TO SEM-HR.                                                 SR1010
024160      MOVE 0 TO WITHDRAWAL-DATE-S.                                      SR1010
024170      MOVE 0 TO GPA-POINTS-S.                                           SR1010
024180      MOVE 0 TO GPA-HOURS-S.                                            SR1010
024190      MOVE 0 TO TOT-HOURS-S.                                            SR1010
024200      MOVE 0 TO SAT-HOURS-S.                                            SR1010
025010      MOVE 0 TO ENTRANCE-DATE-S.                                        SR1010
025020      MOVE 0 TO GRADUATION-DATE-S.                                      SR1010
025030      MOVE 0 TO GPA-Q.                                                  SR1010
025040      MOVE 0 TO CLASS-STANDING-Q.                                       SR1010
025050      MOVE ID-C1 TO ID-S.                                               SR1010
025060      MOVE ID-DIV-C1 TO DIV-S.                                          SR1010
025070      MOVE 732 TO ENTRANCE-DATE-S.
025080      MOVE YEAR-C2 TO YEAR-S.
025090      MOVE QTR-C2 TO QTR-S.
025100 PRNT.                                                                  SR1010
025150      MOVE ' ' TO CTL.                                                  SR1010
```

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                                                                          SR1010
025160     NOTE                                                           SR1010
025170     ---------------------CREATE NEW STUDENT FILE-----------------  SR1010
025180     .                                                              SR1010
025190 LOAD-FILE.                                                         SR1010
025200     STOP 'NEW STUDENT FILE TO BE LOADED, IF CK EOB'.              SR1010
026010     OPEN OUTPUT NEW-FILE.                                          SR1010
026020 RC. PERFORM READ-CARDS.                                            SR1010
026030     IF RDR-END-SW = '1' GO TO EOJ-NEW.                             SR1010
026040     MOVE '1' TO NEWFILE-SW.                                        SR1010
026050     PERFORM ADD-RT THRU ADD-EXIT.                                  SR1010
026060     GO TO RC.                                                      SR1010
026070 EOJ-NEW.                                                           SR1010
026080     CLOSE NEW-FILE.                                                SR1010
026090     GO TO CLOSE-2.                                                 SR1010
026100 EOJ.                                                               SR1010
026110     CLOSE STUDENT-FILE.                                            SR1010
026120 CLOSE-2.                                                           SR1010
026130     CLOSE RDR PRNTR.                                               SR1010
026140     STOP RUN.                                                      SR1010
026150 RANDOM-READ.                                                       SR1010
026160     MOVE ID-C1 TO SYMBOLIC-ID-S.                                   SR1010
026170     MOVE '0' TO NO-FIND.                                           SR1010
026180     READ STUDENT-FILE INVALID KEY MOVE '1' TO NO-FIND.             SR1010
026190     MOVE UPDATE-REC TO STUDENT-RECORD.                             SR1010
026200 WRITE-NEW.                                                         SR1010
027010     IF NEWFILE-SW = '1' GO TO NEW-FL.                              SR1010
027020     MOVE STUDENT-RECORD TO UPDATE-REC.                             SR1010
027030     IF RE-WRITE-SW = '1' REWRITE UPDATE-REC GO TO N-EXIT.          SR1010
027040     WRITE UPDATE-REC INVALID KEY DISPLAY
027050       'AC1010, INVAL KEY, DUPE ETC, CK INPUT' UPON CONSOLE         SR1010
027060         GO TO CANC.                                                SR1010
027070 N-EXIT. EXIT.                                                      SR1010
027080 NEW-FL.                                                            SR1010
027090     MOVE STUDENT-RECORD TO NEW-REC.                                SR1010
027100     WRITE NEW-REC INVALID KEY DISPLAY
027110       'AC1010, INVAL KEY, DUPE ETC. CK INPUT' UPON CONSOLE      .  SR1010
027120         GO TO CANC.                                                SR1010
027130     GO TO N-EXIT.
027135     NOTE   ------- DERCANU CANCELS THIS JOB -------------.         SR1010
027140 CANC.                                                              SR1010
027150     ENTER LINKAGE.
027160     CALL 'DERCANU'.                                                SR1010
027170     ENTER COBOL.                                                   SR1010
027180 RE-WRITE.                                                          SR1010
027190     MOVE STUDENT-RECORD TO UPDATE-REC.                             SR1010
027200     REWRITE UPDATE-REC.
/*
// LBLTYP NSD(3)
// EXEC LNKEDT
/&
```

C3 PRINT

This program prints selected records from the file created by C2.

```
// JOB AC 00000        C3   PRINTS STUDENT FILE
// OPTION CATAL
// PHASE C3,S
// EXEC COBOL
001010 IDENTIFICATION DIVISION.                                         SR1020
       PROGRAM-ID 'C3'.
001030 REMARKS.  STUDENT FILE DUMP.                                     SR1020
001035     BENCHMARK VERSION.
001040     REVISED FOR 360 BY DON F.                                    SR1020
001050 AUTHOR.  JIM GARBER.                                             SR1020
001060 DATE-WRITTEN.  MAY-18, 1970.                                     SR1020
001070 ENVIRONMENT DIVISION.                                            SR1020
001080 INPUT-OUTPUT SECTION.                                            SR1020
001090 FILE-CONTROL.                                                    SR1020
001091     SELECT PRNTR ASSIGN TO 'SYS005' UNIT-RECORD 1403 UNIT.
001100     SELECT STUDENT-FILE ASSIGN TO 'SYS052' DIRECT-ACCESS 2311    SR1020
001110         ACCESS IS SEQUENTIAL                                     SR1020
001120         ORGANIZATION IS INDEXED                                  SR1020
001130         RECORD KEY IS ID-S.                                      SR1020
001140 DATA DIVISION.                                                   SR1020
001150 FILE SECTION.                                                    SR1020
001092 FD PRNTR
001093     RECORDING MODE F
001094     LABEL RECORD OMITTED
001095     DATA RECORD IS PRT.
007020 01 PRT.                                                          SR1020
007030     02  CTL  PICTURE X.                                          SR1020
007040     02  BODY  PICTURE X(132).                                    SR1020
001160 FD  STUDENT-FILE                                                 SR1020
001170     RECORDING MODE F                                             SR1020
001180     LABEL RECORD IS STANDARD                                     SR1020
001190     BLOCK CONTAINS 5 RECORDS                                     SR1020
001200     RECORD CONTAINS 155 CHARACTERS                               SR1020
002010     DATA RECORD IS STUDENT-RECORD.                               SR1020
       01  STUDENT-RECORD.
           02  DELETE-S  PICTURE X.
           02  ID-S  PICTURE 9(5).
           02  DIV-S  PICTURE 9.
           02  NAME  PICTURE X(23).
           02  SEX-S  PICTURE X.
           02  MARITAL-STATUS-S  PICTURE X.
           02  CLASS-STANDING-S  PICTURE XX.
           02  BIRTHDATE-S  PICTURE 9(7) COMPUTATIONAL-3.
           02  STATE-COUNTRY-S  PICTURE XXX.
           02  COUNTY-S  PICTURE XX.
           02  VISA-S  PICTURE X.
           02  CONFERENCE-S  PICTURE XX.
           02  ADMISSION-STATUS-S  PICTURE X.
           02  SECONDARY-SCHOOL-S  PICTURE XX.
           02  COLLEGE-S  PICTURE XX.
           02  DEGREE-COLLEGE-S  PICTURE X.
           02  FILLER  PICTURE X.
           02  COURSE-OF-STUDY-S  PICTURE XX.
           02  MAJOR-OR-DEGREE-S  PICTURE XX.
           02  ENTRANCE-STATUS-S  PICTURE X.
           02  HS-GPA-S  PICTURE 9V99 COMPUTATIONAL-3.
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                   02  HR-ACCUMS  COMPUTATIONAL-3.
                       03  FALL-HR  PICTURE 99V9.
                       03  WINTER-HR  PICTURE 99V9.
                       03  SPRING-HR  PICTURE 99V9.
                       03  SUMMER-HR  PICTURE 99V9.
                       03  COLL-HR  PICTURE 99V9.
                       03  GRAD-HR  PICTURE 99V9.
                       03  SEM-HR  PICTURE 99V9.
                   02  HRS-REDEFINED REDEFINES HR-ACCUMS COMPUTATIONAL-3.
                       03  HR-ACCUM-S   PICTURE 99V9 OCCURS 7 TIMES.
                   02  RESIDENCE-STATUS-S  PICTURE X.
                   02  SOCIAL-STATUS-S  PICTURE X.
                   02  WITHDRAWAL-DATE-S  PICTURE 99999 COMPUTATIONAL-3.
                   02  GPA-DATA  COMPUTATIONAL-3.
                       03  GPA-POINTS-S  PICTURE 999V99.
                       03  GPA-HOURS-S  PICTURE 999V99.
                       03  TOT-HOURS-S  PICTURE 999V99.
                       03  SAT-HOURS-S  PICTURE 999V99.
                   02  SCHOOL-CODES.
                       03  SCH-CODE-S  PICTURE X OCCURS 4 TIMES.
                   02  RELIGION-S  PICTURE X.
                   02  ENTRANCE-DATE-S  PICTURE 999 COMPUTATIONAL-3.
                   02  GRADUATION-DATE-S  PICTURE 999 COMPUTATIONAL-3.
                   02  GPA-DATA-BY-QTR  COMPUTATIONAL-3.
                       03  GPA-Q  PICTURE 9V99.
                       03  CLASS-STANDING-Q  PICTURE  999.
                   02  FILE-DATE.
                       03  YEAR-S  PICTURE 99.
                       03  QTR-S  PICTURE 9.
                   02  ADVISOR-S  PICTURE XX.
                   02  PHONE-S  PICTURE S9(11) COMPUTATIONAL-3.
                   02  STATISTICS-STATUS-S.
                       03  STAT-STATUS-S  PICTURE X OCCURS 4 TIMES.
                   02  ETHNIC-ORIGIN  PICTURE X.
                   02  FILLER          PICTURE X(23).
                   02  SORT-S  PICTURE X(12).
       002030 WORKING-STORAGE SECTION.                                          SR1020
       002040 01  LN-1A.                                                        SR1020
       002050      02  FILLER.                                                  SR1020
       002060          03  FILLER           PICTURE X.                          SR1020
       002070          03  FLD-1            PICTURE X.                          SR1020
       002080          03  FILLER           PICTURE X(5).                       SR1020
       002090          03  FLD-2            PICTURE X.                          SR1020
       002100          03  FILLER           PICTURE X(6).                       SR1020
       002110          03  FLD-3            PICTURE XX.                         SR1020
       002120          03  FILLER           PICTURE X(5).                       SR1020
       002130         03  FLD-4            PICTURE 9(6).                        SR1020
       002140          03  FILLER           PICTURE XXXX.                       SR1020
       002150          03  FLD-5            PICTURE XXX.                        SR1020
       002160          03  FILLER           PICTURE X(5).                       SR1020
       002170          03  FLD-6            PICTURE XX.                         SR1020
       002180      02  FILLER               PICTURE X(4).                       SR1020
       002190      02  FLD-7                PICTURE X.                          SR1020
       002200      02  FILLER               PICTURE X(6).                       SR1020
       003010      02  FLD-8                PICTURE X.                          SR1020
       003020      02  FILLER               PICTURE X(6).                       SR1020
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003030        02  FLD-9                        PICTURE XX.                               SR1020
003040        02  FILLER                       PICTURE XXX.                              SR1020
003050        02  FLD-10                       PICTURE XX.                               SR1020
003060        02  FILLER                       PICTURE X(5).                             SR1020
003070        02  FLD-11                       PICTURE XX.                               SR1020
003080        02  FILLER                       PICTURE X(7).                             SR1020
003090        02  FLD-12                       PICTURE XX.                               SR1020
003100        02  FILLER                       PICTURE X(6).                             SR1020
003110        02  FLD-13                       PICTURE XX.                               SR1020
003120        02  FILLER                       PICTURE X(7).                             SR1020
003130        02  FLD-14                       PICTURE X.                                SR1020
003140        02  FILLER                       PICTURE X(6).                             SR1020
003150        02  FLD-15                       PICTURE 9.99.                             SR1020
003160        02  FILLER                       PICTURE X(4).                             SR1020
003170        02  FLD-16                       PICTURE 99.9.                             SR1020
003180        02  GRP-FLD-2.                                                             SR1020
003190            03  FILLER                   PICTURE X(5).                             SR1020
003200            03  FLD-17                   PICTURE 99.9.                             SR1020
004010            03  FILLER                   PICTURE X(7).                             SR1020
004020 01  LN-2A.                                                                        SR1020
004030        02  FILLER                       PICTURE X.                                SR1020
004040        02  FLD-18                       PICTURE 99.9.                             SR1020
004050        02  FILLER                       PICTURE X(4).                             SR1020
004060        02  FLD-20                       PICTURE 99.9.                             SR1020
004070        02  FILLER                       PICTURE XXXX.                             SR1020
004080        02  FLD-21                       PICTURE 99.9.                             SR1020
004090        02  FILLER                       PICTURE X(5).                             SR1020
004100        02  FLD-22                       PICTURE 99.9.                             SR1020
004110        02  FILLER                       PICTURE X(6).                             SR1020
004120        02  FLD-23                       PICTURE X.                                SR1020
004130        02  FILLER                       PICTURE X(7).                             SR1020
004140        02  FLD-24                       PICTURE X.                                SR1020
004150        02  FILLER                       PICTURE X(6).                             SR1020
004160        02  FLD-25  PICTURE 9999.                                                  SR1020
004170        02  FILLER                       PICTURE XXX.                              SR1020
004180        02  FLD-26  PICTURE ZZZ.99.                                                SR1020
004190        02  FILLER                       PICTURE XXX.                              SR1020
004200        02  FLD-27  PICTURE ZZZ.99.                                                SR1020
005010        02  FILLER                       PICTURE X(4).                             SR1020
005020        02  FLD-28                       PICTURE X.                                SR1020
005030        02  FILLER                       PICTURE X(6).                             SR1020
005040        02  FLD-29                       PICTURE 99B9.                             SR1020
005050        02  FILLER                       PICTURE X(5).                             SR1020
005060        02  FLD-30                       PICTURE XX.                               SR1020
005070        02  FILLER                       PICTURE X(5).                             SR1020
005080        02  FLD-31                       PICTURE X.                                SR1020
005090        02  FILLER                       PICTURE X(6).                             SR1020
005100        02  FLD-32                       PICTURE 99B9.                             SR1020
005110        02  FILLER               PICTURE X(5).                                     SR1020
005120        02  FLD-33  PICTURE ZZZ.99.                                                SR1020
005130        02  FILLER  PICTURE X.                                                     SR1020
005140        02  FLD-34  PICTURE ZZZ.99.                                                SR1020
005150        02  FILLER               PICTURE X(3).                                     SR1020
005160 01  LN-1.                                                                         SR1020
005170        02  FILLER  PICTURE X(20)  VALUE 'SEX MARITAL  CLASS  '.                   SR1020
005180        02  FILLER  PICTURE X(20)  VALUE '  BIRTH  ST/CTRY  CN'.                   SR1020
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005190         02  FILLER   PICTURE X(20)  VALUE 'TY  VISA ADM-STAT H-'.       SR1020
005200         02  FILLER   PICTURE X(20)  VALUE 'S  COLL COL-DEG CRSE'.       SR1020
006010         02  FILLER   PICTURE X(20)  VALUE '-STDY  MJ/CG ENTRANC'.       SR1020
006020         02  FILLER   PICTURE X(20)  VALUE 'E H-S-GPA  AU-CRS   '.       SR1020
006030         02  FILLER   PICTURE X(12)  VALUE 'WI-CRS      '.               SR1020
006040 01  LN-2.                                                                SR1020
006050         02  FILLER   PICTURE X(20)  VALUE 'SP-CRS  COL-HR  GRAD'.       SR1020
006060         02  FILLER   PICTURE X(20)  VALUE '-HR  SEM-HR  RESDNCE'.       SR1020
006070         02  FILLER   PICTURE X(20)  VALUE '  SOCIAL  W-DATE  GP'.       SR1020
006080         02  FILLER   PICTURE X(20)  VALUE 'A-PTS  GPA-HRS  S-CD'.       SR1020
006090         02  FILLER   PICTURE X(20)  VALUE '  ENT-DATE  CONF  RE'.       SR1020
006100         02  FILLER   PICTURE X(20)  VALUE 'LIG  GRAD-DATE  TOT-'.       SR1020
006110         02  FILLER   PICTURE X(12)  VALUE 'HRS  S-HRS  '.               SR1020
006120 01  FILLER.                                                              SR1020
006130         02  S-CODE  PICTURE X VALUE ' '.                                 SR1020
006140         02  LINE-CNT  PICTURE S999 COMPUTATIONAL-3 VALUE 59.             SR1020
006150         02  LN-0A.                                                       SR1020
006160             03  NAME-A              PICTURE X(25).                       SR1020
006170             03  FILLER              PICTURE XX VALUE '  '.               SR1020
006180             03  ID-A   PICTURE S9999.                                    SR1020
006190             03  FILLER              PICTURE X  VALUE '-'.                SR1020
006200             03  ID-DV-A             PICTURE X.                           SR1020
007010         02  PAG-CTR  PICTURE S999 COMPUTATIONAL-3 VALUE 0.               SR1020
007050 01  HEADING.                                                             SR1020
007060         02  DATE-P PICTURE X(8).                                         SR1020
007070         02  FILLER  PICTURE X(10) VALUE SPACES.                          SR1020
007080         02  FILLER  PICTURE X(24) VALUE 'STUDENT FILE PRINTOUT, '.       SR1020
007090         02  GRP-FLD-1 PICTURE X(17).                                     SR1020
007100         02  FILLER   PICTURE X(10) VALUE SPACES.                         SR1020
007110         02  HD-2A.                                                       SR1020
007120             03  FILLER              PICTURE X(7)  VALUE 'FOR YR '.       SR1020
007130             03  YR-P                PICTURE XX.                          SR1020
007140             03  FILLER              PICTURE X(5) VALUE ' QTR '.          SR1020
007150             03  QTR-P               PICTURE X.                           SR1020
007160             03  FILLER  PICTURE X(19) VALUE SPACES.                      SR1020
007170         02  PAG-LN.                                                      SR1020
007180             03  FILLER  PICTURE X(8)   VALUE '   PAGE '.                 SR1020
007190             03  PAG-NO  PICTURE ZZZ.                                     SR1020
007200             03  FILLER  PICTURE X(5) VALUE SPACES.                       SR1020
008010 PROCEDURE DIVISION.                                                      SR1020
008015         NOTE    ----- GETDATE PUT CURRENT DATE IN DATE-P -------.
008020 HOUSE-KEEPING.                                                           SR1020
008030         ENTER LINKAGE.                                                   SR1020
008040         CALL 'GETDATE' USING DATE-P.                                     SR1020
008050         ENTER COBOL.                                                     SR1020
008055         OPEN OUTPUT PRNTR.                                               SR1020
008130         MOVE '5' TO S-CODE.
008060 OPEN-F.                                                                  SR1020
008070         OPEN INPUT STUDENT-FILE.                                         SR1020
008080 READ-S.                                                                  SR1020
008090         READ STUDENT-FILE AT END GO TO CLOSE-UP.                         SR1020
008100 DSPLY.                                                                   SR1020
008140         MOVE YEAR-S TO YR-P.                                             SR1020
008150         MOVE QTR-S TO QTR-P.                                             SR1020
008160 CHECK-CODE.                                                              SR1020
008170         IF DELETE-S = '1' GO TO READ-2.                                  SR1020
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008180     IF S-CODE = 'A' GO TO PER-PRT.                                     SR1020
008190     IF SCH-CODE-S (QTR-S) = S-CODE GO TO PER-PRT.                      SR1020
008200     IF SCH-CODE-S (QTR-S) = '3' AND S-CODE = '4' GO TO PER-PRT.        SR1020
009010     GO TO READ-2.                                                      SR1020
009020 PER-PRT.                                                               SR1020
009030     PERFORM PRINT-RT.                                                  SR1020
009040 READ-2.                                                                SR1020
009050     READ STUDENT-FILE AT END GO TO CLOSE-UP.                           SR1020
009060     GO TO CHECK-CODE.                                                  SR1020
009070 PRINT-RT.                                                              SR1020
009080     IF LINE-CNT GREATER THAN 55 PERFORM PAG-HD THRU PAG-EXIT.          SR1020
009090     MOVE SPACES TO LN-1A.                                              SR1020
009100     MOVE SPACES TO LN-2A.                                              SR1020
009110         MOVE ID-S TO ID-A                                              SR1020
009120     MOVE DIV-S TO ID-DV-A                                              SR1020
009130     MOVE NAME TO NAME-A                                                SR1020
009140         MOVE LN-0A TO GRP-FLD-1,                                       SR1020
009150     MOVE SEX-S TO FLD-1           MOVE MARITAL-STATUS-S TO FLD-2       SR1020
009160     MOVE CLASS-STANDING-S TO FLD-3                                     SR1020
009170     MOVE BIRTHDATE-S TO FLD-4     MOVE STATE-COUNTRY-S TO FLD-5        SR1020
009180     MOVE COUNTY-S  TO FLD-6         MOVE VISA-S TO FLD-7               SR1020
009190     MOVE ADMISSION-STATUS-S TO FLD-8                                   SR1020
009200     MOVE SECONDARY-SCHOOL-S TO FLD-9                                   SR1020
010010     MOVE COLLEGE-S TO FLD-10      MOVE DEGREE-COLLEGE-S TO FLD-11      SR1020
010020     MOVE COURSE-OF-STUDY-S TO FLD-12                                   SR1020
010030     MOVE MAJOR-OR-DEGREE-S TO FLD-13                                   SR1020
010040     MOVE ENTRANCE-STATUS-S TO FLD-14                                   SR1020
010050     MOVE HS-GPA-S TO FLD-15       MOVE FALL-HR TO FLD-16               SR1020
010060     MOVE WINTER-HR TO FLD-17      MOVE SPRING-HR TO FLD-18             SR1020
010070                                   MOVE COLL-HR TO FLD-20               SR1020
010080     MOVE GRAD-HR TO FLD-21        MOVE SEM-HR TO FLD-22                SR1020
010090     MOVE RESIDENCE-STATUS-S TO FLD-23                                  SR1020
010100     MOVE SOCIAL-STATUS-S TO FLD-24                                     SR1020
010110     MOVE WITHDRAWAL-DATE-S TO FLD-25                                   SR1020
010120     MOVE GPA-POINTS-S TO FLD-26   MOVE GPA-HOURS-S TO FLD-27           SR1020
010130     MOVE SCH-CODE-S (QTR-S) TO FLD-28 MOVE RELIGION-S TO FLD-31        SR1020
010140     MOVE ENTRANCE-DATE-S TO FLD-29.                                    SR1020
010150     MOVE CONFERENCE-S TO FLD-30.                                       SR1020
010160     MOVE GRADUATION-DATE-S TO FLD-32.                                  SR1020
010170     MOVE TOT-HOURS-S TO FLD-33.                                        SR1020
010180     MOVE SAT-HOURS-S TO FLD-34.                                        SR1020
010185     MOVE '-' TO CTL.
010190     MOVE LN-0A TO BODY, PERFORM PRNT.                                  SR1020
010200     MOVE LN-1 TO BODY, PERFORM PRNT.                                   SR1020
011010     MOVE LN-1A TO BODY, PERFORM PRNT.
011015     MOVE '0' TO CTL.
011020     MOVE LN-2 TO BODY, PERFORM PRNT.                                   SR1020
011030     MOVE LN-2A TO BODY  PERFORM PRNT.                                  SR1020
011040     ADD 8 TO LINE-CNT.                                                 SR1020
011050 PAG-HD.                                                                SR1020
011060     MOVE 0 TO LINE-CNT.                                                SR1020
011070     ADD 1 TO PAG-CTR.                                                  SR1020
011080     MOVE PAG-CTR TO PAG-NO.                                            SR1020
011090     IF S-CODE = 'A' MOVE 'ALL STUDENTS' TO GRP-FLD-1.                  SR1020
011100     IF S-CODE = '4' MOVE 'COLLEGE STUDENTS' TO GRP-FLD-1.              SR1020
011110     IF S-CODE = '5' MOVE 'GRADUATE STUDENTS' TO GRP-FLD-1.             SR1020
```

```
011120     IF S-CODE = '6' MOVE 'SEMINARY STUDENTS' TO GRP-FLD-1.         SR1020
011130     MOVE PAG-LN TO GRP-FLD-2.                                      SR1020
011140     MOVE HEADING TO BODY, MOVE '1' TO CTL, PERFORM PRNT.           SR1020
011160 PAG-EXIT.  EXIT.                                                   SR1020
011170 CLOSE-UP.                                                          SR1020
011180     MOVE 59 TO LINE-CNT.                                           SR1020
012010     CLOSE STUDENT-FILE.                                            SR1020
012020     IF S-CODE = '5' MOVE '6' TO S-CODE, GO TO OPEN-F.
012021     CLOSE PRNTR.
012030     STOP RUN.                                                      SR1020
012040 PRNT.                                                              SR1020
012050     WRITE PRT AFTER CTL.
012080     MOVE ' ' TO CTL.
/*
// LBLTYP NSD(3)
// EXEC LNKEDT
/&
```

```
// JOB AC 00000          C3   PRINT FILE
// DLBL SYS052,'BENCHMARK FILE',01/001,ISE
// EXTENT SYS021,AU0000,4,1,10,10
// EXTENT SYS021,AU0000,1,2,20,100
// EXTENT SYS021,AU0000,2,3,120,10
// EXEC C3
/&
```

C4 COPY

This program copies the index sequential file to a sequential file.

```
// JOB AC C0000          C4  COPY FILE FOR SORTING
// DLBL SYS011,'BENCHMARK SORT',0
// EXTENT SYS021,AU0000,1,0,150,100
// DLBL SYS052,'BENCHMARK FILE',0,ISE
// EXTENT SYS021,AU0000,4,1,10,10
// EXTENT SYS021,AU0000,1,2,20,100
// EXTENT SYS021,AU0000,2,3,120,10
// EXEC C4
/&
```

```
// JOB AC CCCCC          C4   COPY STUDENT FILE
// OPTION CATAL
// PHASE C4,S
// EXEC COBOL
001010 IDENTIFICATION DIVISION.                                          SR1321
       PROGRAM-ID 'C4'.
001030 AUTHOR. WPN.                                                      SR1321
001040 REMARKS. COPY STUDENT FILE TO BACK-UP.                            SR1321
001050 DATE WRITTEN. SEPT. 9.                                            SR1321
001060 ENVIRONMENT DIVISION.                                             SR1321
001070 CONFIGURATION SECTION.                                            SR1321
001080 SOURCE-COMPUTER. IBM-360.                                         SR1321
001090 OBJECT-COMPUTER. IBM-360.                                         SR1321
001100 INPUT-OUTPUT SECTION.                                             SR1321
001110 FILE-CONTROL.                                                     SR1321
001120     SELECT STUD-FILE ASSIGN TO 'SYS052' DIRECT-ACCESS 2311        SR1321
001130         ORGANIZATION IS INDEXED                                   SR1321
001140         RECORD KEY IS ID-S                                        SR1321
001150         ACCESS IS SEQUENTIAL                                      SR1321
001160         RESERVE NO ALTERNATE AREA.                                SR1321
001170     SELECT STUD-OUT ASSIGN TO 'SYS011' DIRECT-ACCESS 2311         SR1321
001180         ACCESS IS SEQUENTIAL.                                     SR1321
001190 DATA DIVISION.                                                    SR1321
001200 FILE SECTION.                                                     SR1321
002010 FD  STUD-FILE                                                     SR1321
002020     RECORDING MODE IS F                                           SR1321
002030     BLOCK CONTAINS 5 RECORDS                                      SR1321
002040     RECORD CONTAINS 155 CHARACTERS                                SR1321
002050     LABEL RECORD IS STANDARD                                      SR1321
002060     DATA RECORD IS STUD-REC.                                      SR1321
002070 01  STUD-REC              PICTURE X(155).                         SR1321
002080 FD  STUD-OUT                                                      SR1321
002090     RECORDING MODE IS F                                           SR1321
002100     BLOCK CONTAINS 11 RECORDS                                     SR1321
002110     RECORD CONTAINS 155 CHARACTERS                                SR1321
002120     LABEL RECORD IS STANDARD                                      SR1321
002130     DATA RECORD IS STU-REC.                                       SR1321
002140 01  STU-REC.                                                      SR1321
002150     02  FILLER                 PICTURE X(155).                    SR1321
002160 PROCEDURE DIVISION.                                               SR1321
002170 BEGIN.                                                            SR1321
002180     OPEN INPUT STUD-FILE                                          SR1321
002190          OUTPUT STUD-OUT.                                         SR1321
002200 START.                                                            SR1321
003010     READ STUD-FILE INTO STU-REC AT END GO TO END-FL.              SR1321
003020     WRITE STU-REC.                                                SR1321
003030     GO TO START.                                                  SR1321
003040 END-FL.                                                           SR1321
003050     CLOSE STUD-FILE STUD-OUT.                                     SR1321
003060     STOP RUN.                                                     SR1321
/*
// LBLTYP NSD(3)
// EXEC LNKEDT
/&
```

C5 SORT

This program should sort the sequential file by school code major (position 92) then student name (positions 8-30).

```
// JOB AC 00000           C5  SORT SEQUENTIAL FILE
// DLBL FILEA,'BENCHMARK SORT',0
// EXTENT SYS021,AU000C,1,0,150,100
// DLBL FILEW,'BENCHMARK WORK',0,DA
// EXTENT SYS021,AU000C,1,0,250,200
// DLBL FILEO,'BENCHMARK SORT',0
// EXTENT SYS021,AU000C,1,0,150,100
// EXEC DSORT
   SORT FIELDS=(92,1,A,8,23,A),FORMAT=BI,SIZE=1500
   RECORD LENGTH=(155),TYPE=F
   INPFIL BLKSIZE=(1705,X),INPUT=D
   OUTFIL BLKSIZE=(1705),OUTPUT=D
   END
/&
/&
```

C6 DEMO

This data is to be used for C2 to demonstrate the CREATE feature.

```
// JOB AC 00000          C2   LOAD BENCHMARK FILE
*  SCRATCH PACK ON 191
// DLBL SYS009,'BENCHMARK FILE',C1/001,ISC
// EXTENT SYS021,AU0000,4,1,10,10
// EXTENT SYS021,AU0000,1,2,20,100
// EXTENT SYS021,AU0000,2,3,120,10
// EXEC C2
NEWFILE            DATA CARDS FOLLOW THIS CARD
000877BURDICK,ALFRED W            12112043047   02104 90                          X172N
000965COBB,JANICE                 22010246039   02114 90                          X172N
001816ENGLISH,EDWIN A             12020631213   02288 85                          X172N
002644HART CHARLES LEE            12070643015  40939789198        1         21     172M
002786HIEBERT,ARTHUR              12031235111   02284 90                          X172N
003917LYZANCHUK IWAN              12030231025241 0939899999       1         21     172M
006726WHITE,HOWARD                12071046015   02284 90                          X172N
007425MURDICK,VIVIENNE CAROLE     21102643025   02152 90                          X172N
007547HANNAH PAMELA WEISS         250406460252440930199999        1         21     172M
009304BANKS JERRY DWAINE          120204490252440930212340        2         21     172M
009864GROZDANIC JOHN              12060139015  4063  14304        1         1      172M
010385CAMPBELL SAMUEL GEORGE      121215322433  02152185                           172N
010677VAN DUINEN DOROTHY H        2205012802524 0930320914        1         21     172M
012314HINCKLEY CHARLES NEIL       12060334055  41135210942        1         21     172M
013026SCHOUN,BEN                  12060248025   02284 90                          X172N
015017KEARNES MARGARET S          22050742025244 0930222569       1         21     172M
015866VANDEMAN LARRY ALLEN        120831450064  22284190                           172N
016465WRIGHT WAYNE K              120523370254  02179190                           172N
017414SHULER CARRELL VICTOR       120503470252440930210116        1         21     172M
018284PARKER ANNA MAE             21080741011  46632289398        1         21     172M
018735SMITH GORDON ROY            121027490254  02148190                           172N
019187CANNON,PAUL                 12010441043   02284 90                          X172N
019416FOWLER,JOHN                 12051535041   18284 90                          X172N
019807JUDD WAYNE REUBEN           121006410264  22152190                           172N
020244UM K MARK ALAN              110408490252440930224110        2         21     172M
022427KUBO SAKAE                  120705260252440950289198        1         2      172M
022647METZGER JAMES IRVIN         120907390252640930520110        1         21     172M
023067SMITH C ROY                 120805260252440930439398        1         21     172M
024816RHODES,GORDON               12102122026   10179 90                          X172N
025555MOON DONOVAN LARRY          121113450254  02179190                           172N
025755BLUE,RUTH A                 21091949025   02108 90                          X172N
025774RADOSTIS RUTH ELLEN         210309480252540930220175        2         21     172M
025844ROW WENDELL NEIL            110606470252440940210508        1         21     172M
026314RADOSTIS DANIEL JERRY       110602500252440930220165        1         2      172M
026334SHADDUCK TERRIE ANN         210608500252440930210914        1         21     172M
026663SMITH CHANA                                                                  172L
026704HAMEL GARY PAUL             110111540252440910221355        1         21     172M
026894JONES MEREDITH JOY          210111540252440910210130        1         21     172M
026904JORDAN THOMAS JEREMY        110102540252440910299999        1         21     172M
026924REGESTER MARGARET E         210106540252440910290763        1         21     172M
026944ROY BRENDA JEAN             210106530252440910222569        1         11     172M
027004BELL ROSE ANNA              210311520252440930222569        1         21     172M
027014SMITH LARRY ARTHUR          110505510252440934921553        1         21     172M
027034LEE STEVEN HUNTER           110306530252440930229999        1         21     172M
027124CHRISTOFFEL JOSEPH L        1104075202524 0940220155        1         21     172M
027164HERDMAN G DOUGLAS           110412520252440930210116        1         2      172M
027194VITRANO EDWIN JUSTUS        110605510252440930224171        1         21     172M
027204LEE BRUCE ELWIN             110405520252440930211512        1         21     172M
```

```
027214LIPPI PAUL STEPHEN            1104095202524409302123 42     1      21      172M
027224NEUMANN RONALD ALAN           110403520252440930220165      1      21      172M
027264SPICER NANCY SUE              210211510479046735186198      1      21      172M
027344MAURO STEVEN DALE             110604510252440930211316      1      21      172M
027384ANTISDEL DONALD GREG          110606510252440930520959      1      21      172M
027394CAMERON BRUCE NORMAN          110612500252440930211310      1      21      172M
027444JORDAN CANDACE MICHELE        210612510252440930210130      1      21      172M
027474REGESTER RANDY GENE           110604510252440930211505      1      21      172M
027534OPSTAD MARCIA LUETTE          210610510252440930710914      1      21      172M
027564RASMUSSEN KENNETH E           110512500055   41130812342    1      11      172M
028404CARLEY EDWARD ALLEN           110604420252440930220724      1      21      172M
029437LIPPI NORMA JETT              220811270252440939799399      1      11      172M
032044BUURSMA SUZANNE H             210401460254840949722569      1      21      172M
032704LUKE JAMES ELDON              111305470252440937320142      1      21      172M
032756MANIER LINTON G               120228420254   12284190                      172N
033395PRIME PETER                   120108402433   68160185                      172N
033487BARTLETT FRANCES MAY          220712160252440940289198      1      21      172M
033914HARE DENNIS RAY               110608510252440930220173      1      21      172M
034074JOHNSON TERESA KAY            210105530252440910210125      1      11      172M
035374ANDERSEN CONNIE GAIL          210102560252440910281598      1      21      172M
035653DAVIS CHARLES                                                              172L
035724DURHAM ROBERT EARLE           120610490252440930124171      1      21      172M
035954HALVORSEN MYRTLE MARIE        210205500252740920299999      1      11      172M
036044HILL DEBORAH KAY              210403520252440930214947      1      21      172M
036184KINNEY MARCIA ANN             210609510252440930220175      1      11      172M
036274LABIANCA TORMOD               110610500331   10934911504    1      11      172M
036343MAURO NANCY                                                                172L
036434OLES GARY THOMAS              110412510252440941424598      1      21      172M
036524SCHNEIDER NOEL KEITH          1106075002524409402 1  57     1      21      172M
036534SCHWARZ CONSTANCE KAY         210408520252440930220175      1      21      172M
036654COOPER CHARLOTTE SPEER        240104530252440919899999      1      21      172M
036764UMEK DENA JEAN                210408510252440930224175      1      21      172M
036854ASHDON JUDITH HARRIET         210308530252440930222569      1      21      172M
036874SNYDER KAREN LEE              210110540252440910220162      1      21      172M
037244RUECKERT CAROL ANN            210306520 16   40920120155    1      21      172M
037284SIMMONS JO ANN                210309510252440830222569      2      21      172M
037544PLUE GEORGE SAMUEL            110504510252440930220138      1      21      172
037834CHURCH LOWELL GRANT           110201540252648939919930      2      11      172
038194RUSSELL CAMERON C             130304500252440930290199      2      21      172
038294SCHMIDT HERNAN SAMUEL         110609510732440930211534      1      21      172
038304SCHMIDT DORA NILDA            210111153295   48510780498    1      11      172
039107KRONCKE,JOHN ANDREW           120430280 25   10152 90                     X172
039775RODMAN,DONALD                 111022450 36   06104 90                     X172
040094WEAKLEY MICHAEL GLENN         110311510252440930220253      2      21      172
040334MASHNI SAMUEL FUAD            110406520252440930211508      1      11      172
040504HOWARD YVONNE CLAIRE          210304540252440930262184      1      21      172
040644FREEMAN CHERRY LAONE          210109540252440910283798      1      21      172
040654FREEMAN APRIL JEAN            210312510252440930210136      1      21      172
040694CHRISTENSEN JUDITH I          211006520252440930287598      1      21      172
040706CHAMBERLAIN LYLE AMOS         120928280394   10284190                      172
041803CASTELBUONO ROY                                                            172L
041814DU BOSE RICHARD C             110110520 11   46619812342    1      11      172
043444SMITH DARRELL HARR            110301330252449349710125      1      11      172
043484POTTER MARY CHAVANNES         220512280 21   40931620959    1      21      172
043856QUASHIE,CLEOPHAS              120628230 25   68284 90                     X172
043936FOLL MELVIN E                 120530370154   02284187                      172
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044246TRIPP,MIRIAM                 21080912025    16284 90                         X172N
044375PENNER DAVID STEPHEN         120501490254   52160187                          172N
044805ABBOTT,MARY                  22041338025    70128 99                         X172N
047337REAVES,BENJAMIN              12112232036    14284 90                         X172N
047527ROY BARBARA LAMY             220803260252440829729398       1        21       172M
051344JARRARD WARREN LEE           120610470252440940421553       1        21       172M
052235GAGER SHIRLEY ETHEL M        220920420254   02152190                          172N
052304HANN JULIE M                 210401520252440930220914       2        11       172M
052976BRIDGES JOHN THOMAS          150508400194   18284190                          172N
053015COUPLAND RALPH M             121222300251   16179190                          172N
053486MATACIO DOUGLAS C            111118470154   02284190                          172N
054185WAGNER JOHN H                120514490434   14148190                          172N
054764WITT CAROL JEAN              2106124502524  0939710724      1        21       172M
055825STEINBACHER MARIE DIAZ       220425420254   06152190                          172N
056216STRUNTZ YUERGEN              120425470254   02284190                          172N
056325DELACRUZ ISABELLE            12030829025    02172190                          172N
056705VOTH ORLOW DAVID             120403390254   70179293                          172N
058264LINCOW DANIEL ROSWELL        12050847055    41130820251     1        21       172M
058655CALKINS YVONNE ELIE          220305470254   02122190                          172N
058965PLUMMER,RAYMOND              12080346015    02172 90                         X172N
059174YANCEY DAVID HUGH            12061246016    40740712342     2        21       172M
060367PHILLIPS HAROLD ROGER        121106280254   18164190                          172N
060774MASSENGILL PAUL ROBERT       11060747016    40730720155     1        11       172M
061356BOHR,HAROLD                  12042223005    02284 85                         X172N
061536GODSOE,DONALD                121203371113   08284 90                         X172N
061986SPENCER,BERNARD              12021939042    24296 90                         X172N
062324VENDEN SUSAN MARIE           210102550252440911499999       1        21       172M
062404SIMMONS LEON                 110312520252440830229999       1        21       172M
062964LECHLEITNER THOMAS E         121308470252440930610108       1        21       172M
063474SHELINE SUSANNE PAMELA       210405510253840930522569       1        11       172M
064496HITLALL,AARON R              12050628435    06284 85                         X172N
064737HUNT ROGER WILLIAMS          120707190252440939789198       1        21       172M
065174BOM ROBERT STEVEN            110308500252440930211320       1        21       172M
065416BELTZ MYRON DENNIS           111106480384   02284190                          172N
065443HELM JR HERBERT                                                               172L
065744HABENICHT LINDA JOY          210303530252440930223798       1        21       172M
066014WILLS ROSEANNE               210308530252440930219999       1        21       172M
066213GEMMELL LOIS                                                                  172L
066294MIDDAUGH RUTH MARIE          210602510252740930622569       1        21       172M
066554HOPKINS HOLLY JEAN           210503510253340930624171       1        11       172M
067324WOODARD NORA                 21061047016    40849714116     1        11       172M
067394OSTER CYRUS KENNETH          110305510252440930310502       1        11       172M
067944FRIESTAD BARBARA JEAN        21031053015    40630499999     1        11       172M
068107RAUNIO LEO L                 120529120254   16172190                          172N
069944SHOW KATHRYN LARI            210110540252440910214306       1        21       172M
070594WASHBURN HAROLD THOMAS       11040846036    41938020165     1        11       172M
070624BAUER RAELENE JOAN           210305530252440930829999       1        21       172M
071046KLINGER,DONALD               12012847016    02284 90                         X172N
071184BOHR STEPHEN PAUL            12050650055    40840812342     1        21       172M
071204WOLF LOVERA LEE              21060851016    40730211508     1        11       172M
071964CATHCART CAROLYNN            210501480256040939814304       1        11       172M
072126SWANSON,JOHN                 12061344015    02284 90                         X172N
072496HUBER,DAVID                  11082848039    02284 90                         X172N
073776BENNETT,JAMES                12072027243    68284 85                         X172N
074384CRISTANCHO DANIEL J          12041234125    18549914140     1        21       172M
074644STRINGER LINDA JOY           210511470252440930722569       2        21       172M
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075806MOORE,BRUCE                12072549025   02284 90                      X172M
076246HUTAURUK,JAN               12081627229   02284 84                      X172M
076425TREPPER PETER JOHN         120311490434  02148190                       172M
077475SELESKE KENNETH LEE        110923470154  02148190                       172M
080066HOPKINS,JIM                11081648025   02284 90                      X172N
080105STANTON,JANICE             22090449043   02108 90                      X172N
080245MOON,MARGARETE             22110648025   02152 90                      X172M
080446WARD JAMES DARYLL          111121470254  02284187                       172M
080694FROST GERTRUDE ELVIRA      2107044402524409397225 69     1      21      172M
081075STRUNTZ WOLFGANG D         120708480254  02152190                       172N
081237RETTERER MURIEL JONES      22041021025244093971 4116     1      21      172M
081306WARD REX MICHAEL           12111442C474  18284190                       172N
081654WRIGHT CYNTHIA ANN         21040853036   41938010110     1      11      172M
081906GOODING,WILMA              21042220435   02296 90                      X172M
082185LONG ALBERT MEL            120902300054  16172189                       172N
083494BRONSON ANNA KATHLEEN      2206085102524409408225 69     1      21      172M
083644RASCH RANDOLPH FRITZ R     110311520252740830222569      1      21      172M
083824BERLIN DEBORAH RUTH        210102540252440910299999      1      11      172M
083894RETTERER STEVEN R          120105540252440910210110      1      21      172M
084024HERFORD GRETCHEN RAE       210407520252440930220914      1      2       172M
084074MCCLELLAN PAMELA JEAN      210410520252440930514116      1      21      172M
084144RUSK GERRIE ANN            210606510252440930220155      1      21      172M
084214STREET GREGORY RANDALL     110408520252440920220108      1      11      172M
084504SCHAFER BRIAN EVERETT      11060648016   40939714242     1      11      172M
084514SHADLER ANITA PARREN       220501320252449339720959      1      21      172M
084664WILSON YVETTA WEEKS        210405360252440747427161      2      21      172M
084794BAKER SALLY ANNE           210107540252440910299999      1      21      172M
084864LLOYD DONALD LEE           110403490258240930120110      1      11      172M
085064JOHNSTON ROBERT FENTON     110111530252440910212308      1      21      172M
085094KAMP OLIVE ILENE           21010952015   40910522569     1      11      172M
085224KRONCKE ARTHUR JOHN        110312520252440930211504      1      21      172M
085474BURLINGAME GARY M          110105540252440910214905      1      21      172M
085554PLUMB MAUREEN JOANNE       210305530252440930234185      1      21      172M
085594RITLAND STANLEY MARTIN     110401540252440930221553      1      21      172M
085844HODGE ROLENE JEANNETTE     210304540252440940520161      1      21      172M
085874COLLARD WILLIAM GLEN       110112530252440910299999      1      21      172M
086144ORR MARGARET LORRAINE      210412510252440930210914      1      11      172M
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087157GREGG ALONZO EARL          120809440252440934989399      1      11      172M
087687GILBERT THELMA GIBBS       220610220254  02172190                       172N
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091966HIEBERT,JACOB              12061840113   08284 90                      X172N
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135904NORRIS CLARENCE EUGENE	120602480252140940611508	1	21	172
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137043STREETER YVONNE				172
137264PFLITZ THEODORE JACK	120602450252440938311512	1	21	172
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138024INCE JOSHUA XAVIER	12041139025241 39812342	1	21	172
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139026WESLEY PHILIP MCGUIRE	120505422191 14284190			172
139064ELMENDORF NINA MARIE	210608510259240930120959	2	11	172
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157955MCGUCKIN MICHAEL E	110904450194 22172190			172

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166854PAYNE ALBERT EDWARD JR      11060452039  44239711512      1      11     172M
166864PORTER WAYNE RICHARD        11030853036  42033234185      1      11     172M
166894HORRICKS DEBRA SAYERS       22030553111  22839920498      1      21     172M
166904SEAY ZELDA ELAINE           210312520258240839714104      2      11     172M
166914SLIKKERS CLAUDIA            210508510251740930620914      1      11     172M
167504ENGELKEMIER JOETTA MAE      210304520252440931120959      1      21     172M
167524GIBBONS JUNE ANNETTE        21030652089  28539920763      1      11     172M
167554HEYD MARSHA LEE             210203530258340930521976      1      11     172M
167574JENNINGS MICHELLE A         21040253023  43831410914      1      11     172M
167594LEWIS HELEN ANGELLA         21  0950415  28539914130      1      11     172M
167604MANCHUR FREDDIE M           11040152111  22839920155      1      11     172M
167644CHRISTMAN JOYCE EVELYN      22060651048  47543722569      1      21     172M
167654REIMCHE CARLENE SUELLA      21051248111  22439924171      1      21     172M
167664SINCLAIR BARBARA JEAN       21030551047  46749720161      1      11     172M
167694SWENSEN JACKIE LEE          210303530252640930387598      1      11     172M
167704SWETT DONNA JEAN            210301530252640930320102      1      11     172M
167714WEBSTER ROBERT EUGENE       11040352015  40639711512      1      11     172M
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C7 DEMO

This data is to be used for C2 to demonstrate the UPDATE feature.

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// JOB AC 00000              UPDATE BENCHMARK FILE
// DLBL SYS052,'BENCHMARK FILE',01/001,ISE
// EXTENT SYS021,AU0000,4,1,10,10
// EXTENT SYS021,AU0000,1,2,20,100
// EXTENT SYS021,AU0000,2,3,120,10
// EXEC C2
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000065ALLISON,BONNIE              22050832043    02120 90                        X172N
000695BRELOWSKI,BOBBIE            22072225025    02114 99                        X172N
000795BRUGMANN,GERTRUDE           25112133025    02152 90                        X172N
000877BURDICK,ALFRED W            12112043047    02104 90                        X172N
000965COBB,JANICE                 22010246039    02114 90                        X172N
001015CAVINESS,R LEWIS            11012646025    02164 90                        X172N
001265CLINITE,RICHARD             12061943015    02152 90                        X172N
001465COX,GERRY LEE               12122244016    02132 99                        X172N
001816ENGLISH,EDWIN A             12020631213    02288 85                        X172N
002246GATZ,LYNN                   12042546025    02284 90                        X172N
002644HART CHARLES LEE            12070643015   40939789198      1        21      172M
003496KONRAD ALBERT               120922430154   02284190                         172N
003795LEMON,DUANE                 12090941018    02152 90                        X172N
003845HABENICHT,CHERRY            22071246038    02152 90                        X172N
003917LYZANCHUK IWAN              120302310252410939899999       1        21      172M
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004215MERIWEATHER LEWIS           120903450434   02152190                         172N
005245ROUSH,DUANE                 12062244025    02152 90                        X172N
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006465VEINE,ERIK                  12102944025    02152 90                        X172N
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007547HANNAH PAMELA WEISS         250406460252440930199999       1        21      172M
007615ANDERSON,BRUCE              12080945025    02152 90                        X172N
008205LANGE,RICHARD               12083144025    02152 90                        X172N
008865COOPER,GILBERT              12012946025    14152 90                        X172N
009295HUFFAKER,GEORGE             12090821015    02152 90                        X172N
009304BANKS JERRY DWAINE          120204490252440930212340       2        21      172M
009864GROZDANIC JOHN              12060139015  4063   14304      1         1      172M
010545CHEESEMAN,PETER             12022842025    02156 90                        X172N
010677VAN DUINEN DOROTHY H        2205012802524 0930320914       1        21      172M
012195HEWLETT,GORDON E            12030544025    02152 90                        X172N
012314HINCKLEY CHARLES NEIL       12060334055   41135210942      1        21      172M
012915KOWALSKI,MADELINE           21012035025    02179 90                        X172N
013305MACKLIN,KATHRYN             22061627025    02132 90                        X172N
013315MACKLIN,ROBERT              12050926025    02124 90                        X172N
013345MAHLUM,LARRY                12042143055    02146 89                        X172N
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015565SUMNER,CAROL                22032540025    02152 90                        X172N
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016145WILKE,LILLIAN               21122334025    02179 90                        X172N
016175WILLIAMS,BOB                12021638039    02152 90                        X172N
016465WRIGHT WAYNE K              120523370254   02179190                         172N
017145SCHONE,ALFRED S             12102248025    02152 90                        X172N
017414SHULER CARRELL VICTOR       120503470252440930210116       1        21      172M
018695STONE,THOMAS                22110925047    18152 90                        X172N
018705STREIDL,HAROLD              12121635043    02148 90                        X172N
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018735SMITH GORDON ROY           121027490254  02148190                    X172N
019416FOWLER,JOHN                12051535041   18284 90                     172N
019807JUDD WAYNE REUBEN          121006410264  22152190                    X172N
019896LARSON,RALPH               12111420024   12284 90                    X172N
020115MCKNIGHT,GLEN              12081541036   06152 90                     172M
020244UMEK MARK ALAN             110408490252440930224110     2     21     X172N
020606SPEYER,JOHN                12071831005   22172 90                    X172N
020846ZACKRISON,EDWIN            12101541005   12296 90                     172M
022647METZGER JAMES IRVIN        120907390252640930520110     1     21      172M
023067SMITH C ROY                120805260252440930489398     1     21     X172N
024205BRISTOW JR,HARVEY          12060441048   10152 90                    X172N
024546SUMPTER JR,WARD            12122435011   14280 90                    X172N
024816RHODES,GORDON              12102122026   10179 90                     172M
025774RADOSTIS RUTH ELLEN        210309480252540930220175     2     21      172M
025844ROW WENDELL NEIL           110606470252440940210508     1     21      172M
026314RADOSTIS DANIEL JERRY      110602500252440930220165     1     2       172M
026334SHADDUCK TERRIE ANN        210608500252440930210914     1     21      172M
026704HAMEL GARY PAUL            110111540252440910221355     1     21      172M
026894JONES MEREDITH JOY         210111540252440910210130     1     21      172M
026904JORDAN THOMAS JEREMY       111002540252440910285998     1     11      172M
026944ROY BRENDA JEAN            210106530252440910222569     1     11      172M
027004BELL ROSE ANNA             210311520252440930222569     1     21      172M
027014SMITH LARRY ARTHUR         110505510252440934921553     1     21      172M
027034LEE STEVEN HUNTER          110306530252440930229999     1     21      172M
027094SMITH STANL   SCOTT        110208520252440830290110     2     21      172M
027164HERDMAN G  UGLAS           110412520252440930210116     1     2       172M
027194VITRANO EDWIN JUSTUS       110605510252440930224171     1     21      172M
027204LEE BRUCE ELWIN            110405520252440930211512     1     21      172M
027214LIPPI PAUL STEPHEN         110408520252440930212342     1     21      172M
027264SPICER NANCY SUE           210211510478046735186198     1     21      172M
027344MAURO STEVEN DALE          110604510252440930211316     1     21      172M
027394CAMERON BRUCE NORMAN       110612500252440930211310     1     21      172M
027444JORDAN CANDACE MICHELE     210612510252440930210130     1     21      172M
027474REGESTER RANDY GENE        110604510252440930211505     1     21      172M
027534ORSTAD MARCIA LUETTE       210610510252440930710914     1     21      172M
027564RASMUSSEN KENNETH E        11051250055   41130812342    1     11      172M
028404CARLEY EDWARD ALLEN        110604420252440930220724     1     21      172M
029004HORSLEY JUDITH JENNINE     21040350111   10939999999    1     11      172M
029437LIPPI NORMA JETT           220811270252440939799399     1     11      172M
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032704LUKE JAMES ELDON           111305470252440937320142     1     21      172M
033914HARE DENNIS RAY            110608510252440930220173     1     21      172M
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037014IVERSON GREGORY ALLEN      110401520258040930210104     2     21      172M
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037834CHURCH LOWELL GRANT        110201540252648939919930     2     11      172M
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040214POPP LYNDA SUZANNE        2103085202524409302101 25       2        21        172M
040334MASHNI SAMUEL FUAD        1104065202524409302115 08       1        11        172M
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043936FOLL MELVIN F             12053037015 4   02284187                           172N
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047116ROBINSON,JOHN             12021425005     24284 90                          X172N
047337REAVES,BENJAMIN           12112232036     14284 90                          X172N
047536NEMBHARD,HILBERT          12082320243     06284 85                          X172N
047714DOUGLAS YVONNE IANTHE     2207094002524108399891 98       1        21        172M
051216SAMMS ROBERT OSWALD       12051239243     08284185                           172N
051344JARRARD WARREN LEE        1206104702524409404215 53       1        21        172M
051714ALGER DWIGHT EUGENE       1204124602524409303149 31       1        21        172M
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052976BRIDGES JOHN THOMAS       15050840019 4   18284190                           172N
054764WITT CAROL JEAN           210612450252 4 0939710724       1        21        172M
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057274REECE CAROLYNE JEAN       2206114402524409307409 81       1        21        172M
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062964LECHLEITNER THOMAS E      1213084702524409306101 08       1        21        172M
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065416BELTZ MYRON DENNIS        11110648038 4   02284190                           172N
065744HABENICHT LINDA JOY       2103035302524409302237 98       1        21        172M
065894FISK DARYL CRAIG          1102035302524409302101 10       1        11        172M
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071046KLINGER,DONALD            12012847016     02284 90                          X172N
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083494BRONSON ANNA KATHLEEN      220608510252440940822569     1      21      172M
083504HILDEBRAND BRADLEY E       110109520252440919721599     1      21      172M
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084504SCHAFER BRIAN EVERETT      11060648016  40939714242     1      11      172M
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084664WILSON YVETTA WEEKS        210405360252440747427161     2      21      172M
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097074BLOOD BARBARA ANN          210602490252340930520959     1      11      172M
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099034NEWBERRY DOUGLAS R         120601490257110939724136     1      21      172M
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103114HANDS LESTER MAXWELL       11010953111  12819930189     1      11      172M
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103714GRENTZ WERNER              110401490256440930521557     1      21      172M
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106674HALL MELODIE ANN           21030353243  28539914116     1      11      172M
107994OLMSTEAD LYNN LEROY        12061142036  49338020136     1      21      172M
108294RUBLESKE JOHN MICHAEL      110805470252449349789398     1      21      172M
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110234INGERSOLL HELEN MARIE      211303500252440930521976     1      21      172M
110314LANCE PAUL EMERY           11061050043  43931422569     1      21      172M
110374DAVID JANE MARSH           22060449016  40730722569     1      21      172M
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110744SHEPHARD WILLIAM           12060450053  40931111505     1      21      172M
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111174FORD JANNELLE ANN          21061049016  40730722569     1      11      172M
111537BOOMSLITER WILLIAM F       120411370252440930510110     1      21      172M
111614HURON MERITA SCHNEIDER     220504230252449339710102     1      21      172M
111674LOEROP FREDERICK JAN       11040350011  46639710104     2      11      172M
112007ENGELKEMIER DON            120803330252440939789398     1      21      172M
112334BITZER MERLIN DAVID        120607410252440939722569     1      21      172M
112374DAVIS ALVIN L              11060951043  43739710104     1      11      172M
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112634SUNDIN JACQUELINE RAE      210609490252440930520959     2      21      172M
112864HALL STEPHEN JOHN          110601500252440930534185     1      21      172M
112874HALL THOMAS FRANCIS        120606510252440930512342     1      21      172M
114734DINNING DONOVAN BRUCE      11050449005  46137210136     1      11      172M
114744ELLISON VIVIAN LILA        21061250015  10630822569     1      11      172M
114974WOHLERS MARY KATHLEEN      210603500253140940521976     1      11      172M
115234SANOCKI JOHN JOSEPH        12060548034  44142414129     1      11      172M
115694HOWARD JANE MONICKAM       220601460252410839922569     1      21      172M
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116964USHER WILFRED ADAIR        11061272009  43737811319     1      11      172M
117174TAYLOR LYNDON DOUGLAS      120603500252440740423108     1      21      172M
117444BUTLER JON MALCOLM         110404520252440930220155     1      21      172M
118074SPIVEY ARMEL LYNN          110210530252440930299999     2      21      172M
118094WAZDATSKEY PHILIP D        110106530252440910299999     1      21      172M
118274FALCONBRIDGE VAIDA M       210312530252448439930190     1      21      172M
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118664DIXON JUDY CAROL           210311520258240930184998     2      11      172M
118864SCHUCK TERESA MARY         210208530252440939799999     1      21      172M
118964BUTLER JOANNE MARIE        210107540252440910229999     1      21      172M
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119074STRUM DEBRA KAY            210101540252440910217122     1      21      172M
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122014HARTBAUER CHRISTINE A      210407520252440930220144     1      21      172M
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126404ASHTON DAVID FREDRIC       110502510256540940120179         1        11        172M
126434BOUCHARD ROBERT FRANK      11060851036  41833214128         1        11        172M
126444BRENNEISE HARVEY RAY       11060151005  45735314119         1        11        172M
126544FARVER LAHNA CORINNE       21060251043  43931424122         1        11        172M
126644KIJAK JOHN JR              11060651034  44131411508         1        11        172M
126694NICOLAUS VICTORIA S        21060351039  44239720959         1        11        172M
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127064WILBURN MARK JAMES         110506510256540930529955         1        21        172M
127144LINDO ELLEN ELIZABETH      21060448011  4  39810122         1        11        172M
127364ANDERSON SHARON ESTELL     21060751036  42039711705.        1        11        172M
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127874BAKER JOHN DANIEL          11060651034  40930310128         1        11        172M
127894BONNIER LINDA LOUISE       21050851055  40939712569         1        11        172M
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127944MCCLINTOCK LAVANNA LEE     21061250043  43941424136         1        11        172M
127964OSTERMAN CHARLOTTE M       21060451045  4693  10104         1        11        172M
127974SPRUILL TIMOTHY EUGENE     110608510252640940310105         1        11        172M
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ANDREWS UNIVERSITY

SUPPLEMENT TO REQUEST FOR BENCHMARK

Berrien Springs, Michigan

December 19, 1972

SUPPLEMENT TO REQUEST FOR BENCHMARK

Purpose

Since one of the major academic functions of the upgraded computer system will be to process large statistical batch jobs, we feel it is useful to have a demonstration of the proposed system capabilities in this area.

Provisions

The statements contained in the "Request For Benchmark," dated December 11, 1972, in paragraphs "Purpose," "Time Frame," and "Evaluation of Results", apply to this supplement as well.

Applications Package Test

Data enclosed, "F6 FACTOR," is to be processed using the FORTRAN statistical subroutines proposed for use at Andrews University on the bid system. Make coding changes as required to process data F6. Submit a listing of the programs as executed, compile-through-load time for each program. Timing is to be based on the system interval timer (make coding changes required for its use with each program).

FORTRAN DATA

F6 Factor

This data was prepared from 222 responses to a 128 question survey questionnaire. The responses were coded from 1 to 5 on a ascending scale where 1 was an unfavorable and 5 was a very favorable response. Failure to respond was coded as a 6. Each questionnaire required two 80 column cards for the 128 questions. The first two columns of each card were reserved to indicate whether the card was the first or second in the set. Columns 3 through 52 on card one contain data for the first 50 questions, and columns 3 through 80 on card two contain data for the remaining 78 questions.

The data should be processed using the factor analysis routines which are part of the statistical applications package proposed for use on the bid system.

Desired output includes (but is not necessarily limited to):

1. Means
2. Standard deviations
3. Correlation coefficient matrix
4. Eigenvalues
5. Eigenvectors
6. Factor Matrix
7. Variance of the factor matrix for each iteration cycle
8. Rotated factor matrix
9. Communalities

Please retain 10 eigenvalues for steps 5 through 9. Please submit a listing of all programs as executed.

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26555 Evergreen
Southfield, Michigan 48076
313 353-4200

5 January 1973

Mr. Leroy H. Botten
Director, Computer Center
Andrews University
Berrien Springs, Michigan 49104

Dear Mr. Botten:

Xerox has at your request undertaken and executed the Andrews Benchmark Study. This brief report has been prepared to convey the procedure used, the equipment employed and to present selected summary results of our efforts. The primary purpose of the study was to demonstrate the capacity to execute the supplied programs. We feel that we have met this objective. In addition the completed output contains a substantial amount of data that defines quite accurately what occured in the system while the programs were being executed. No attempt has been made in this report to provide Andrews with a complete explanation of system operation during the test. Rather we have selected for presentation those results that we believe to be of general interest to the selection committee. Should you or other members of the committee desire further definition or explanation of the detailed technical aspects of the test, I will arrange the necessary presentation at a mutually acceptable time.

The accompanying report contains the following sections.

I. Equipment Configurations
II. System Tuning Parameters
III. The Test Procedures
IV. Summary of Results

The Appendix Material Includes:

A. Equipment Lists
B. Test Procedures
C. Program Source Listings
D. Execution Listings
E. Utilization Analysis
F. Basic Language Tests
G. Time Sharing Users Terminal Output

The Exhibit Material Includes:

A. Program C3 execution and output listing
B. Program F6 execution and output listing
C. Multiprogramming Run #1 - Dual Batch, no T/S users
D. Multiprogramming Run #2 - Dual Batch, 5 T/S users
E. Single Batch Stream F2 - F5 compile, load, and execute

Yours very truly

L.D. Felton

L. D. Felton
Account Manager

Andrews University
Benchmark Report

as

Developed by Xerox

INTRODUCTION

This report summarizes pertinent aspects of the Xerox execution of the Andrews benchmark request of December 12, 1972. The report contains the following sections.

I. Equipment Configurations
II. System Tuning Parameters
III. The Testing Procedures
IV. Summary of Results

I. Equipment Configurations

There are two variations between the equipment used to execute the benchmark programs and that proposed for Andrews University (as defined in the January 4, 1973 configuration and price revision).

The first variation results from using perepherial devices that are not identical to those proposed for Andrews. The line printer used for the benchmark is not currently offered by Xerox. The Model 7445 printer used in the test has been replaced by the 7441 proposed for Andrews. The 7445 was rated at approximately 1000 lines per minute while the 7441 is rated at 1100 lines per minute. The time variation between the two should therefore be negliable but improved print quality can be expected. Because so few cards were punched in the benchmark (the only cards punched contained job accounting data) no significant variations should have been introduced. All other perepherial devices were the same model number (or of the same rated speed) as those contained in the proposal.

Because all detailed system performance statistics gathered by the operating system exclude actual perepherial device time encountered by the symbiont system, the only variation introduced by differences in rated perepherial speeds would be caused by changes in the pattern of interrupts and differences in the end-action processing for the different devices.

The combined effect of these differences are likely to be undetectable.

The second potential variation is from differences in the number and type of I/O channels, I/O ports and the position of the perepherials in the priority interrupt heirachy. The effect of the variations in CPU time should be extremely small but they may cause differences in such values as I/O wait time. Because the Andrews proposal currently contains an IOP expansion feature we would not anticipate any significant system performance variations.

In summary the equipment used for the benchmark tests very closely approximates the proposed equipment. We believe that the benchmark results are representative of the results that Andrews can expect from the equipment currently under consideration. Lists of the equipment proposed and used in the benchmark are presented in the Appendix (Section A).

II. System Tuning Parameters

UTS is perhaps the most complete time sharing operating system available from any computer manufacturer. As a result a number of operating system characteristics have been identified that can substantially effect the manner in which the system performs. To permit UTS to be "tuned" to a specific customers needs and operating environment these characteristics have been set up as variables. A user may (after measuring system performance with various settings) control the performance of the system by changing the values of these variables. Xerox has made no attempt to tune the system used to run the benchmark programs. An attempt to replicate the results of the benchmark should be done with system control variables set equal to those origionally employed.

Subject to the limitations above and with potentially minor adjustments introduced by equipment variations Xerox feels sure that the Andrews equipment when installed will yield substantially the same system performance.

III. The Testing Procedure

In general Xerox viewed the benchmark as a two phase effort. The first phase was the conversion or preparation of the test programs and the second was the execution ot the programs to obtain the necessary operating statistics.

Xerox approached the program preparation effort by employing two different groups. The Applications Systems Division (the group currently estimating the Andrews conversion effort) was used for COBOL conversion and for setting up the package used for the addendum. This was done to take advantage of the specialized skills of the individuals and the ready access of computer room facilities. The remaining programs were made ready by technical members of the Detroit office using the time sharing facilities in El Segundo, California.

Xerox has currently designated a group in El Segundo, California, that has as its prime responsibility the execution of customer requested benchmarks. After all programs were prepared, they were gathered in El Segundo and executed according to the implementation plan presented in Appendix B. This test procedure was discussed with members of the Andrews staff prior to its implementation.

IV. Summary of Results

The results presented have been keyed to the test procedure presented in the Appendix (Section B). Both the test procedure and these results have been ordered to follow the sequence in the benchmark request.

Conversion Test (test procedure I-A)

Source listings of COBOL programs C1, C2, C3, C4 and FORTRAN F6 are presented in Appendix C. This Appendix also contains a description of the software package used for F6. COBOL program C5 is a sort and was developed with the C00 version of the Xerox SORT package. The only effort expended was to punch the required control cards. As a result no conversion effort or source listing has been provided for C5. The effort required to prepare the remaining COBOL programs for execution is outlined below.

Program	Number Translation Attempts Required	Number of Tests Required	Minutes of Analysts Time
C1	1	0	35
C2	2	2 (one each)	65
C3	4	2	90
C4	2	1	30

All program changes were input via a teletype on a time sharing system. Tests and translator outputs were returned via remote batch terminal. The analyst performing the conversion did not enter a computer installation during the conversion period which spanned two days.

In order to provide the above listings and a base point for subsequent reference, programs C2 through C5 and F6 were run in a single batch stream. The results of execution of C2 #1, C2 #2, C4 and C5 are presented in Appendix D. Exhibits A and B (see accompanying binder) contain the results (including output) of executing C3 and F6 respectively. Appendix E, Exhibit 2 contains the result of running a Xerox Computer Utilization Analysis. Exhibit 1 of Appendix E defines in general terms the Xerox Computer Utilization Analysis Program.

Dedicated Machine Performance Tests (test procedure IIA, IIB)

The results from step II (A and B) of the test procedure are outlined below.

	Program	Compile Time	Execution Time
Time Sharing Mode	B8	less than .1 sec	40.5 seconds
	C1	one second	108.5 seconds
	F1	one second	14.5 seconds
Batch Mode	B8	less than .1 sec	38.0 seconds
	C1	one second	108.5 seconds
	F1	one second	14.5 seconds

A performance analysis for the above is contained in Appendix E as a portion of Exhibit 3.

Language Tests (test procedure IIIA, IIIB, and IIIC)

The results of this section were obtained by storing input data on disk packs. Listings and output data for Basic programs B1 through B7 are presented in Appendix F.

COBOL source listings are presented in Appendix C. The result of executing these programs is presented in Appendix D. The output from C3 is presented in Exhibit A. Appendix E, Exhibit 2 presents an analysis of this sequence. The values observed were.

Program	Elapsed Time	CPU Time
C2	48.0 seconds	.39 minutes
C3	30.0 seconds	.20 minutes
C4	15.0 seconds	.05 minutes
C5	25.0 seconds	.12 minutes

The observed compile through load statistics for the programs F2 through F6 are as follows.

Program	Elapsed Time	CPU Time
F2	43.0 seconds	.60 minutes
F3	13.0 seconds	.13 minutes
F4	10.0 seconds	.11 minutes
F5	15.0 seconds	.13 minutes
F6	141.0 seconds	1.95 minutes

An analysis of these tests is included in Exhibit 3, Appendix E. Exhibit E contains the output from the executed job stream.

Multiprogramming and Concurrent Processing Tests

The benchmark request asked for four separate tests to be run is this environment. Each test was to recycle each of two batch streams. The numbers of time sharing users was to be varied from 0 through 15 in steps of 5. The observed results are as follows.

Test 1(no time sharing users)	Elapsed Time	CPU Time
COBOL sequence time (CST)	4 min 3 sec	.55 min
Fortran sequence time (FST)	7 min 5 sec	2.39 min

Test 2 (5 time sharing users)

COBOL sequence time (CST)	4 min	24 sec	.55 min
Fortran sequence time (FST)	8 min	29 sec	2.41 min

Tests 3 and 4 were not completed due to the difficulty of arranging for the required number of terminal users. The terminal user output is contained in Appendix G. A computer utilization output report for each of the above tests is contained in Appendix E as Exhibits 4 and 5 respectively. Exhibits C and D contain the actual output listings from these two tests.

APPENDIX MATERIALS

APPENDIX A

Equipment List

Equipment Lists

Item	Test System	Proposed System
	Description or Model Numbers	
Operating System	UTS	same
Central Processor	Sigma 6	same
Memory Size	64 K words	same
Tape Units	2-60 KB drives	same
Card Reader	7140/1500 CPM	7122/400 CPM
Card Punch	7160/300 CPM	7165/100 CPM
Line Printer	7445/1000 LPM	7441/1100 LPM
Disk Storage	7242/Dual Spindle	same
Rad Storage	7232	same
Operators Console	7012	same

ANDREWS UNIVERSITY BENCHMARK RESULTS(1)

CONVERSION TEST

Man hours required to convert C1, C2, C3, C4, C5 were 4 hours including keypunching.

Central processor time was about 10 minutes and elapse time about 30 minutes.

DEDICATED MACHINE PERFORMANCE TESTS

Batch runs:

RUN	ELAPSE	CPU
B8	Conversational language could not run batch.	
C1	1 + min	59.6686 sec
F1	1 + min	81.5788 sec

Timesharing runs:

---

(1) These notes were typed from handwritten notes supplied by Univac.

RUN	ELAPSE	CPU
B8	183	183.7112
C1	71 sec	59.2587
F1	2 min	81.0175

LANGUAGE TESTS

B1 through B7

27 minutes hookup time

6.7649 CPU time

COMPILE AND EXECUTE

C2	3 min	49.3066 sec
C3	1 min	39.5606
C4	1 min	15.5457
C5	1 min	7.9547
Update C2	1 min	10.0619
F2	1	27.1733
F4	1	30.6788
F5	1	29.3286

MULTIPROGRAMMING TESTS

Dedicated runs:

	START	STOP	ELAPSE
CST	1626	1628	2 min
FST	1813	1817	4 min

Multiprogramming without timesharing:

	START	STOP	ELAPSE
CST	1805	1808	3 min
FST	1805	1810	5 min

Multiprogramming with timesharing:

		START	STOP	ELAPSE
Run 1	CST	1851	1856	5 min
	FST	1851	1857	6 min
Run 2	CST	1858	1904	6 min
	FST	1858	1906	8 min

APPENDIX H

XDS
Xerox Data Systems

TYPE A

LEASE AGREEMENT

Term ________ year (s)

Lessee ________________________
State of Incorporation ________________________
Street Address ________________________
Equipment Location Street Address ________________________
City ________ State ________ Zip Code ________
City ________ State ________ Zip Code ________

Xerox Data Systems, Inc. (hereinafter called XDS) agrees to lease to the above named Lessee at the above address, and the Lessee agrees to accept for the lease amounts stated herein, XDS computing equipment noted below (excluding Program Products) installed and ready for Lessee's use, together with instructions in the operation of the equipment and maintenance service on the equipment, upon the terms and conditions hereinafter stated in this Agreement.

Item	Model No.	Qty.	Description	Basic Monthly Charge Each	
				Unit Charge	Item Charge
Sales Price of Equipment $ ________				Total: $	

Delivery Date ________________

XDS will provide Maintenance Service on the above equipment in accordance with both Paragraph 6 of this contract and the following:

A. Service Hours:
Regular Service Hours will be ________ to ________ Monday through Friday, excluding holidays and one hour meal period.
Extended Service Hours will be ________ to ________, ________ through ________ for an additional monthly charge of $________.

B. Optional Local Service will be provided for an additional monthly charge of $________.

C. "On-Call" Maintenance will be provided for in accordance with Paragraph 6 of this contract up to an amount not to exceed $________.

AGREED TO THIS

________ day of ________ 19____

____
Lessee

____
By

____
Title

____
Attest.

ACCEPTED THIS

________ day of ________ 19____

XDS Xerox Data Systems
701 South Aviation Blvd., El Segundo, California 90245

____
By

____
Title

Lease Number ________________

1373 1(12/69) XEROX DATA SYSTEMS

1. LEASE TERM
The lease term shall commence when service begins and continue for the number of years shown. After the initial period, the lease will remain in effect until terminated by either party with three months written notice. Upon expiration of the lease term, or extension thereof, Lessee shall return the equipment in good condition with allowance for normal wear and tear.

2. MONTHLY CHARGES
The basic monthly charges shall be payable on the installation date of the equipment for the calendar month in which equipment is first installed and shall be prorated to the end of the month, and thereafter shall be paid for each calendar month on the first day of that month.

3. TAXES
The Lessee will pay any Sales, Use Tax, or Import Tax. XDS will pay the Personal Property Tax.

4. INSTALLATION PERMITS
Lessee will prepare the site in accordance with XDS's written site specifications 15 days prior to the scheduled delivery date. XDS will install the equipment. Lessee will provide labor for unpacking and locating the equipment. Lessee will assume responsibility for compliance with local laws and will obtain any permits required for installation and use.

5. SOFTWARE
XDS software identified as "Control Programs" will be provided by XDS under the terms of this equipment lease agreement; maintenance service will be provided for standard, current versions of such Control Programs.

XDS software identified as "Program Products" are not furnished under this agreement. Program Products will be made available to the Lessee on a fee basis pursuant to an XDS software licensing agreement executed by the Lessee.

6. MAINTENANCE
During the Regular and Extended Service Hours shown on the face of this agreement XDS will accomplish regularly scheduled preventive maintenance, provide replacement parts as needed, and make available, upon request, maintenance personnel for corrective maintenance.

Maintenance occasioned by the negligence of the Lessee, or by the use of attachments not provided by XDS, or by any abnormal use, is not covered by the monthly charge and Lessee agrees to pay for such services at XDS's then current rate.

The Lessee agrees to give XDS access to the equipment when necessary for maintenance.

If the face of the agreement indicates Optional Local Service is to be provided, XDS will locate one or more service technicians within 100 miles of the installation.

If Optional Local Service is not to be provided and the installation is beyond 100 miles from an XDS service center, Lessee agrees to pay transportation, lodging and subsistence for all calls in excess of one per week.

Lessee will pay for Maintenance Services requested to be performed outside the Regular and Extended Service Hours defined on the face of this agreement at the hourly rates, including travel time, in effect at the time such service is performed. There is a two hour minimum for all services performed on an hourly basis.

If the equipment remains inoperative for 48 consecutive hours after maintenance service has been requested, rental of the inoperative equipment and nonusable interconnected XDS equipment will thereafter abate until operation is restored. This rental abatement expresses XDS's entire liability for inoperative equipment. Lessee will pay the full amount of invoices submitted by XDS 30 days after their date, without deducting rental abatement or other credits until XDS and Lessee agree on the amount of the credit and XDS issues a credit memo in the agreed upon amount. Claims for downtime must be initiated in writing within seven (7) working days after the incident.

7. DELAYS, DAMAGES
XDS shall not be liable for delays in delivery or failure to manufacture due to causes beyond its reasonable control. In the event of any such delay, the date or dates for performance of this contract by XDS shall be extended for a period equal to the time lost by reason of delay. In no event shall XDS be liable for incidental or consequential damages under this lease.

8. ALTERATIONS, ATTACHMENTS
No alterations or attachments to the leased equipment shall be made without XDS's written approval.

9. TRANSPORTATION AND PACKING
Lessee will pay all transportation and rigging charges to and from the installation site and will return the equipment to XDS's plant by air freight, or by van equipped for transporting electronic equipment, unless XDS has approved in writing an alternate method of shipment. Lessee will not move the equipment to another location without XDS's consent.

10. OPTION
Lessee may purchase any of the leased equipment during the term of this lease for its sales price on the date of this lease less 40% of the rentals paid to a maximum of 60% of the sales price.

11. PATENT INDEMNITY
XDS agrees to defend Lessee in any suit brought against him alleging that the articles leased hereunder, uncombined with non-XDS equipment, directly infringe United States Letters Patent owned by others, provided XDS is promptly notified, given assistance required and permitted to direct the defense. Further, XDS will pay any judgment, based on such infringement, rendered in such suit by final judgment of a court of last resort, but shall not be responsible for settlements or costs incurred without its consent. If Lessee's use of such articles is enjoined, or in the event that XDS desires to minimize its liabilities hereunder, XDS will, at its option, either substitute other equally suitable articles, modify the articles so that they no longer infringe, obtain for Lessee the right to continue their use, or take them back releasing Lessee from the obligation of paying rentals not yet due. The foregoing states the entire liability of XDS for patent infringement. No indemnity shall apply to articles made or modified to Lessee's own specifications or design.

12. ASSIGNMENT
Either party may assign its rights and remedies and may also transfer its obligations under this lease. However, the assignment or transfer shall not operate to relieve the assigning party of any of its obligations hereunder. Nor will any such assignment impose any obligation on the assignee except in the case of an express written assumption thereof by the assignee.

13. LOSS OR DAMAGE
XDS agrees that Lessee shall be relieved of all responsibility for any loss or damage to the equipment covered by this agreement, provided that such loss or damage shall not have been caused by theft, unauthorized alteration, negligence or malice of the Lessee or any of its employees or representatives. The Lessee agrees to fully compensate XDS for any loss or damage to the equipment for which Lessee is not relieved of responsibility hereunder.

14. DEFAULT
In the event of any default by Lessee, XDS may, at its option, declare this lease in default and terminate this lease.

If at any time during the Lease Term or any extension thereof, Lessee shall make an assignment for the benefit of creditors or shall become insolvent, or if a receiver or trustee of substantially all of Lessee's property shall be appointed, or if the Lessee (where it is a corporation) shall terminate its existence, or if a petition is filed by or against Lessee pursuant to any of the provisions of the United States Bankruptcy Act, as amended, for the purpose of adjudicating Lessee bankrupt or for reorganization of Lessee or for the purpose of effecting an arrangement or composition with Lessee's creditors, then in each and every such case this lease and any extension thereof shall terminate immediately without any further act or notice by XDS.

Upon termination of the lease pursuant to this Article 14, XDS shall be entitled to immediate possession of the equipment and to any rental sums due and unpaid, together with all other rights and remedies in law or in equity.

TIME SALE AND SECURITY AGREEMENT

XEROX CORPORATION, a New York corporation, acting through its Xerox Data Systems division, 701 South Aviation Boulevard, El Segundo, California 90245 (hereinafter called "SELLER") and ____ (hereinafter called "BUYER") agree as follows:

1. Sale and Purchase. SELLER hereby sells to BUYER, and BUYER hereby purchases from SELLER the several items of equipment listed and described in Schedule A attached hereto and made a part hereof (the "Equipment"), upon the terms and conditions provided herein, and for the Time Sale Price specified with respect thereto on Schedule A, payable as provided in Section 3, but subject to acceleration as provided in Section 9.

2. Security Interest; Transfer of Title. BUYER hereby grants to SELLER a security interest in the Equipment and any and all replacements and substitutions thereof and repairs thereto, for the purpose of securing the payment of the balance of the Time Sale Price from time to time due hereunder and all other liabilities of BUYER to SELLER arising under this Agreement. Title to each item of Equipment shall upon delivery of each such item at the location specified by BUYER pass to BUYER.

3. Payment of Purchase Price. Subject to the provisions of Section 9, the Time Sale Price with respect to each item of Equipment will be paid by BUYER to SELLER in ________ consecutive monthly installments in the amount set forth in Schedule A, such installments to be paid on the first day of each month commencing on ____________________________________.

4. Delivery and Acceptance; Risk of Loss. Delivery of the Equipment shall be made at BUYER's expense to such location in the United States as BUYER shall specify, shipment to be made by SELLER within ________________________ after receiving written notice to deliver from BUYER. Possession of each item of Equipment and the risk of loss thereof or damage thereto shall pass to BUYER upon his acceptance thereof. Such acceptance shall be deemed to occur upon delivery of the Equipment to the location specified. SELLER shall install the Equipment at the location specified in BUYER's written notice, such installation to be in the manner and to include documentation, standard software, and software support normally supplied to customers of SELLER without charge. SELLER shall not be liable for delays in delivery or failure to manufacture due to acts beyond its reasonable control, including but not limited to acts of God, acts or omissions of civil or military

authority, priorities, fire, strikes, floods, restrictions, riots, war, delays in transportation, car shortages, and inability due to causes beyond its control to obtain the necessary labor, materials or manufacturing facilities. In the event of any such delay, the date for performance of this Agreement by SELLER shall be extended for a period equal to the period of time lost by reason of the delay.

5. Taxes. BUYER acknowledges that it is not purchasing the Equipment for resale. All taxes of every description (including sales, use and personal property taxes) arising out of the transactions contemplated hereby (other than taxes on the income of SELLER) shall be borne and paid for solely by BUYER, and BUYER shall pay or shall reimburse SELLER for its payment of any applicable personal property tax with respect to the Equipment accrued after the date hereof.

6. Financing Statement. At the time of execution of this Agreement, BUYER will join with SELLER in executing and filing appropriate financing statements relating thereto in form satisfactory to SELLER. Further, promptly upon delivery and acceptance of each item of Equipment as provided in Section 4, or upon any subsequent relocation of any item of Equipment, BUYER will join with SELLER in executing and filing such further financing statements relating thereto in form satisfactory to SELLER and as SELLER may deem appropriate.

7. Insurance. From the time at which the risk of loss or damage to the Equipment passes to BUYER as provided in Section 4 hereof, BUYER shall procure and maintain, with an insurance carrier acceptable to SELLER, insurance thereon against such risks and in such amounts as SELLER shall reasonably require. Each such policy of insurance shall be endorsed with a standard mortgagee or security certificate or certificates of the insurance carrier or carriers evidencing insurance coverage as herein required.

8. Mutual Covenants and Agreements. SELLER hereby covenants and agrees (i) that it is now and upon delivery and acceptance of any of the Equipments as provided in Section 4 hereof, it will be the owner of such Equipment, free and clear of any and all liens, encumbrances, claims, or security interests other than those to be created hereby, and other than any lien, encumbrance, claim or security interest on or against the Equipment heretofore or hereafter caused or allowed to be caused by BUYER or any subsidiary or affiliated company of BUYER; (ii) that it has now and will then have the full right and power to sell the Equipment to BUYER upon the terms and conditions provided herein; and (iii) that so long as BUYER shall not be in default hereunder and subject to the rights of any third party as a result of any lien, encumbrance, claim, or security interest on or against the Equipment caused or allowed to be caused by BUYER or any subsidiary or affiliated

company of BUYER, BUYER shall be entitled to the sole and exclusive possession and use of the Equipment purchased by and delivered to it hereunder. BUYER hereby covenants and agrees (i) that it now has and that upon delivery and acceptance of any of the Equipment as provided in Section 4 hereof it will have the full right and power to buy the Equipment from SELLER upon the terms and conditions provided herein; (ii) that it will not use or deal with the Equipment in a manner which is inconsistent with the terms of this Agreement, or any policy of insurance referred to in Section 7 hereof, or the applicable laws and regulations of governmental agencies; and (iii) that it will not use the Equipment in any manner which results in unreasonable deterioration or depreciation thereof, and that SELLER shall have the right to inspect the Equipment at any reasonable time, wherever located.

9. Acceleration; Prepayment. (a) Upon any acceleration of the maturity of its obligations with respect to any item of Equipment pursuant to this Section 9 (the Acceleration Date), the BUYER shall pay to the SELLER an amount (the Acceleration Price) which shall be equal to (i) the portion of the Invoice Price of such item (as set forth in Schedule A hereto) which would remain unpaid on the Acceleration Date if such Invoice Price had been borrowed and partially repaid in installments in the same amounts and payable on the same dates as the installments of the Time Sale Price heretofore paid by BUYER for such item and if each such installment payment had been applied first to the payment of interest on such unpaid portion at a rate of____________ percent per annum and the remainder to the Invoice Price, and (ii) interest (computed at __________percent per annum rate from the date of the last preceding installment paid hereunder to the Acceleration Date) on the Invoice Price remaining unpaid as arrived at in (i).

(b) BUYER shall give SELLER not less than fifteen (15) days written notice of any proposed resale or lease of any item of Equipment during the term of this Agreement. Such notice shall state the item or items of Equipment to be resold or leased and the date upon which sale or lease is to be effective. If the Equipment is to be resold or leased, BUYER shall pay to SELLER on or prior to such date the Acceleration Price in respect of such item of Equipment.

(c) If at any time an event of default specified in Section 10 hereof shall have occurred and shall be continuing, SELLER shall have the right, upon written demand to BUYER specifying such event of default, to require BUYER to pay, within ten (10) days after the date of such demand, the Acceleration Price with respect to all of the Equipment then subject hereto.

(d) If any item of the Equipment shall be substantially destroyed or shall be damaged beyond repair, SELLER shall have the right, upon written demand to BUYER, to require BUYER to pay, within ten (10) days after the date of such demand, the Acceleration Price with respect to each item of Equipment so destroyed or damaged, less any proceeds of insurance theretofore received by SELLER with respect to such Equipment.

(e) BUYER shall have the right, exercisable at any time during the term of this Agreement, upon written notice to SELLER specifying the items of Equipment affected, to fully satisfy its obligations hereunder with respect to any or all items of Equipment by the payment to SELLER, not less than ten (10) days nor more than thirty (30) days after the date of such written notice, the Acceleration Price with respect to such items of Equipment. SELLER agrees, on request of BUYER, to confirm in writing to any proposed purchaser or lessee of any of the Equipment from BUYER that, on payment in full to SELLER of the Accelerated Purchase Price, the amount of which Accelerated Purchase Price shall be specified in such notice, SELLER will release its security interest in the Equipment.

(f) SELLER shall release its security interest in any item of Equipment when payment shall have been made with respect thereto as provided in this Section 9, and shall execute such documents furnished by BUYER as may be necessary to evidence such release.

10. Events of Default; Remedies. BUYER shall be in default (a) if it shall fail to pay, or cause to be paid, any installment payable under Section 3 hereof, or any sum payable upon any acceleration under Section 9 hereof when the same is due, or (b) if it shall fail to perform any other term or condition of this Agreement, and such failure shall continue for a period of fifteen (15) days after written notice thereof from SELLER to BUYER, or (c) if Federal bankruptcy, insolvency, liquidation, receivership or like proceedings are initiated by or on behalf of or against BUYER, or any of the Equipment shall be attached, seized or levied upon, and such proceedings, attachment or levy shall not be vacated or fully stayed, within thirty (30) days after the institution or occurrence thereof, or (d) if any of the Equipment shall be sold, leased or encumbered by BUYER other than in accordance with the provisions of Section 9 (b) hereof.

If an event of default shall have occurred and be continuing, SELLER shall have the right to accelerate BUYER's obligations hereunder as provided in Section 9 (e) hereof, and in addition shall have all the rights (not inconsistent with the rights specifically provided herein) of a secured party under the Uniform Commercial Code; or SELLER may, at its option, and it is hereby empowered so to do, enter upon the premises where the Equipment may be and take possession thereof, or remove, sell and dispose of the Equipment and from the proceeds of sale retain all costs and charges incurred by SELLER in the taking or sale of the Equipment including any reasonable attorney's fees thereby incurred; also SELLER may take all sums due it under the terms of this Agreement including reasonable attorney's fees; and any surplus of such proceeds remaining shall be paid to BUYER. The foregoing is without limitation to or waiver of any other rights or remedies of SELLER according to law. It is further agreed that upon any sale of the Equipment according to law, or under the power herein given, that SELLER may bid on the said sale, or make a purchase of the Equipment or any part thereof.

11. Waivers. A waiver by SELLER of a default under this Agreement shall not operate as a waiver of any other default which may thereafter occur.

12. Location of Equipment. Following delivery and acceptance thereof as provided in Section 4, and so long as the Equipment is subject to a security interest of SELLER, the Equipment will be kept at the location specified in BUYER's written notice or at such other location as may hereafter be agreed upon by SELLER and BUYER; during such period BUYER will promptly notify SELLER of any change in the location of the Equipment, and will not remove the Equipment from the aforesaid location, without the prior written consent of SELLER which consent shall not be unreasonable withheld or delayed.

13. Warranty. SELLER warrants that the Equipment is merchantable and that it will replace or repair any components of Equipment manufactured by SELLER which are defective by reason of material or workmanship that the BUYER returns to SELLER within one (1) year from acceptance of the Equipment. This warranty does not extend to program products, nor to expendable items such as pilot lamps and fuses, nor to components that have suffered mechanical wear, such as vacuum motors and punch die blocks, nor to products altered or repaired by personnel other than those employed by SELLER, or trained and certified by SELLER. Shipment of defective parts to SELLER will be paid by BUYER. Return shipment, to the BUYER, of repaired or replaced parts will be paid by SELLER. Operation or storage of the Equipment in an environment other than that selected by SELLER or recommended by SELLER's published specification will invalidate this warranty. There are no other warranties, expressed or implied. In no event shall SELLER be liable for incidental or consequential damages.

14. Patent Indemnity. SELLER agrees to defend BUYER in any suit brought against it alleging that any item of the Equipment sold hereunder uncombined with equipment other than that manufactured by SELLER, directly infringes United States Letters Patent owned by others, provided SELLER is promptly notified, given assistance required, and permitted to direct the defense. Further, SELLER will pay any judgment based on such infringement, rendered in such suit by final judgment of a court of last resort but shall have no liability for statements or costs incurred without its consent. If BUYER's use of any item of Equipment is enjoined, or in the event that SELLER desires to minimize its liabilities hereunder, SELLER will, at its option, either substitute

other equally suitable items of the Equipment, modify such items so that they no longer infringe, obtain for BUYER the right to continue their use, or take them back returning the price less a reasonable amount for use, damage and obsolescence. The foregoing states the entire liability of SELLER for patent infringement. No indemnity shall apply to items of the Equipment made or modified to BUYER's own specifications or design.

15. Notices. All notices or other communications required or permitted to be given pursuant to this Agreement shall be in writing and shall be valid and sufficient if delivered by hand or dispatched by registered or certified airmail, postage prepaid, addressed as follows:

Xerox Data Systems
701 South Aviation Boulevard
El Segundo, California 90245
Attention: Vice President-Finance

or to such other address as either party shall notify the other in writing. Given notices dispatched by registered or certified airmail shall be deemed to have been given three days after such notice is deposited in any post office.

16. Governing Law; Severability. This Agreement shall be construed in accordance with and governed by the internal laws of the State of California. Any provision of this Agreement which may be prohibited by law shall be ineffective to the extent of such prohibition without invalidating the remaining provisions of this Agreement.

17. Equipment Markings. SELLER may mark the Equipment to conspicuously show that it has a security interest therein and BUYER shall place no conflicting marks or indicia on the Equipment or suffer SELLER's marks to be removed or defaced without the written consent of SELLER or until payment in full shall have been made and BUYER shall have fulfilled all of its obligations hereunder.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the ______ ________________ day of ____________________, 1971.

XEROX CORPORATION
XEROX DATA SYSTEMS

By ____________________	By ____________________
____________________ Typed Name	____________________ Typed Name
____________________ Title	____________________ Title

SCHEDULE A

Quantity	Catalog No.	Description	Invoice Price	Down Payment	Monthly Installment *

* The Monthly Installment is equal to the Invoice Price (I. P.) less the Down Payment (____ % of I. P.) times ________, the factor appropriate to amortize a loan in ____________ (___) equal monthly installments at ________ percent per annum on the unpaid balance).

** The Time Sale Price is equal to the sum of the ______ Monthly Installments plus the Down Payment.

Xerox Data Systems

XEROX

MAINTENANCE AGREEMENT

NAME OF OWNER

STREET ADDRESS

CITY STATE ZIP CODE

INSTALLATION NO.

MAIN FRAME S/N

Agreement between ____________________ ____________________ (hereinafter called Owner) and Xerox Data Systems (hereinafter called XDS) for the maintenance of XDS computer system and peripheral equipment per the configuration list and maintenance fees listed in Appendix A, in accordance with the terms and conditions of this contract.

This Agreement is for a fixed period of ____________________ commencing ____________________ , 19____ .

XDS agrees to perform the following basic monthly maintenance service during the Principal Period of Maintenance.

1. Accomplish regularly scheduled Preventive Maintenance.
2. Update the equipment to provide the latest reliability improvements.
3. Supervise the preparation for movement and set-up of the equipment after movement.
4. Provide replacement parts as needed.
5. Make available, upon request, maintenance personnel for corrective maintenance.

A. PRINCIPAL PERIOD OF MAINTENANCE

The Principal Period of Maintenance (PPM) shall be any nine (9) consecutive hours, 7:00 a.m. and 6:00 p.m. (Monday through Friday), with a one (1) hour meal period.

B. EXTENDED COVERAGE

For contracted coverage of more than one shift, the PPM may be extended in the time increments and for the charges shown in the following schedule. The percentage is computed on the total monthly maintenance rate. The hours shown include the Principal Period of Maintenance.

Hours	5 Days	6 Days	7 Days
8	100%	120%	140%
16	140%	170%	190%
24	210%	225%	240%

C. PPM SERVICE HOURS

PPM service hours will be ____________ to ____________ , ____________ through ____________ , excluding holidays, with one (1) hour meal period.

If installation is beyond 100 miles from an XDS service center, the owner agrees to pay transportation, lodging and subsistence for all calls in excess of one (1) per week.

D. OPTIONAL LOCAL MAINTENANCE

The owner whose installation is located more than 100 miles from the nearest XDS service center may reduce the travel charges for which he is liable and diminish the response time by contracting for an XDS Field Engineering Representative to be located within 100 miles of the installation. The price for this relocation is:

1. $1,000 per month if XDS is maintaining only one (1) computer in the area.
2. $300 per month if XDS is maintaining two (2) computers in the area.
3. No charge if XDS is maintaining three (3) or more computers in the area.

XDS ☐ shall, ☐ shall not locate one or more service technicians within 100 miles of the installation.

E. CHARGES

(1) Basic monthly charge per Appendix A ____________

(2) Extended coverage ____________

(3) Optional local service ____________

Sub-Total ____________

____

____

Total Maintenance Charge ____________

Monthly Maintenance Charge ____________

F. EMERGENCY SERVICE

Calls outside the PPM service hours defined in Paragraph C will be provided for at the following rates: Monday through Saturday, except holidays, $____________ per man hour including travel time; Sunday and holidays $ ____________ per man hour including travel time. There is a two (2) hour minimum for all services performed on an hourly basis.

When requested, XDS will provide off-site stand by service outside of the Principal Period of Maintenance at the rate of one (1) man hour for each four (4) hours of stand by. On-site stand by to be charged on a per hour basis.

Agreed to this

____________ day of ____________ , 19____

Name of Owner

Street Address

City State Zip Code

By

Title

Approved and Accepted

____________ day of ____________ , 19____

Xerox Data Systems
701 South Aviation Blvd., El Segundo, California 90245

By

Title

AGREEMENT CONDITIONS

1. GENERAL

Equipment not under XDS lease or maintenance contract immediately prior to the effective date of this maintenance agreement shall be subject to inspection by XDS without charge. If the equipment is not in good operating condition, labor and parts required to place the equipment in good operating condition shall be provided by XDS at the Owner's expense.

2. DURATION OF AGREEMENT

The Owner shall have the right to terminate this Agreement at any time after the first anniversary of the Commencement Date shown on its face, by written notice sent to and received by XDS at least three (3) months prior to the termination date selected by the Owner.

XDS may terminate this Agreement, or change the monthly maintenance or emergency service charge on any or all of the items of equipment covered by this Agreement at any time after the first anniversary of the Commencement Date, by written notice to the Owner three (3) months prior to the effective date of such termination or change. After receipt of notification of any such changes of maintenance charges, the Owner shall have the right to terminate this Agreement, such termination to become effective as the date of the proposed change in maintenance charges, provided that the Owner gives at least 30 days notice of such termination.

3. MONTHLY CHARGES AND TERMS OF PAYMENT

(a) The basic monthly charges for maintenance service shall begin on the Commencement Date shown on the face of this Agreement. For the calendar month in which service starts the charges shall be prorated to the end of the month and thereafter shall be invoiced for each calendar month on the first day of the month.

(b) The Owner agrees to pay the monthly and hourly charges as set forth on the face of this Agreement and to pay an additional amount equal to any taxes, however designated, levied, or based on such monthly charges or upon this Agreement, or any taxes or amounts in lieu thereof paid by XDS or payable by XDS in respect to the foregoing, exclusive of taxes based upon XDS' net income.

(c) Terms 30 days net from date of invoice.

4. RESPONSIBILITIES OF XDS

(a) XDS shall provide maintenance (labor and parts) at the price agreed to and keep the equipment in good operating condition.

(b) Preventive (scheduled) maintenance shall be performed at a time other than the Owner's working hours so long as it is performed during or contiguous to the Principal Period of Maintenance. XDS shall specify in writing the frequency and duration of the preventive maintenance required for the equipment listed on the order and the Owner shall specify the schedule for the performance of the preventive maintenance. This schedule may be modified by mutual agreement.

(c) Remedial maintenance shall be performed after notification that the equipment is inoperative. XDS shall provide the Owner with a designated point(s) of contact and make arrangements to enable his maintenance representative to receive such notification.

(d) XDS shall furnish a malfunction incident report to the installation upon completion of each maintenance call. The report shall include, as a minimum, the following:

(1) Date and time notified.
(2) Date and time of arrival.
(3) Type and model number(s) of machine(s).
(4) Time system made available to XDS.
(5) Time spent for repair.
(6) Description of malfunction.
(7) Corrective action taken including parts used.
(8) Additional charges, if applicable.

(e) Only new standard parts or parts of equal quality shall be used in affecting repairs. Parts which have been replaced shall become the property of XDS.

(f) Maintenance service shall include the items of equipment necessary to the maintenance of the machine being serviced.

(g) XDS sponsored modifications to equipment which are made to rented equipment of the same type as being maintained under the terms of this contract shall be made with the consent of and without charge to the Owner.

5. RESPONSIBILITIES OF OWNER

(a) The Owner shall provide adequate storage space for spare parts and adequate working space, including heat, light, ventilation, electric current and outlets for the use of XDS' maintenance personnel. These facilities shall be within a reasonable distance of the equipment and shall be provided at no charge to XDS.

(b) The Owner's personnel shall not perform maintenance or attempt repairs to equipment while such equipment is under the purview of this contract unless agreed to by XDS.

(c) The Owner shall provide XDS access to the equipment to perform maintenance services. If additional costs are incurred as a result of the Owner's denial of access during the scheduled periods for an unreasonable period of time, the Owner shall bear the cost of returning the equipment to good operating condition.

6. MAINTENANCE

(a) XDS agrees to make available, upon request, maintenance personnel for corrective maintenance. Additionally, if the service is begun during the Principal Period of Maintenance and the difficulty is not corrected on the same day at the end of the PPM service will continue at no extra charge.

(b) The Principal Period of Maintenance or extension thereof may be changed by the Owner upon 30 days written notice.

(c) Corrective maintenance occasioned by the negligence of the Owner, his employees or representatives, or by the use of devices or special attachments not provided by XDS or by any other misuse or abnormal use, is not covered by the monthly charge.

(d) There shall be no additional maintenance charges for time spent by maintenance personnel after arrival at the site awaiting the arrival of additional maintenance personnel and/or delivery of parts, etc., after a service call has commenced.

7. ALTERATIONS AND ATTACHMENTS

If the owner makes alterations or installs attachments to the equipment covered by this Agreement, and if in the opinion of XDS the cost of maintenance is substantially increased, the parties may mutually adjust the maintenance charge for the equipment or XDS may immediately discontinue service for such equipment hereunder.

8. MOVEMENT OF EQUIPMENT

(a) In the event that equipment being maintained under the terms and conditions of this Agreement is moved to another location, XDS shall continue to maintain the equipment at the new location unless such a movement should remove the equipment outside the 48 contiguous states and the District of Columbia.

(b) In the latter instance, the maintenance agreement shall be terminated without further obligations being incurred by either XDS or the Owner.

(c) The Owner shall give at least 30 days written notice of the movement of equipment unless such move is required because of an emergency.

(d) When the shipment is under the control of XDS and damage is incurred which results in abnormal costs for either labor or parts to restore the equipment to good operating condition at the new site, such costs shall be borne by XDS.

(e) When the shipment is under the control of the Owner and damage is incurred which results in abnormal costs for either labor or parts to restore the equipment to good operating condition at the new site, such costs shall be borne by the Owner.

(f) Maintenance charges shall be suspended on the day the equipment is dismantled in preparation for shipment. Maintenance charges shall be reinstated on the day installation and checkout procedure necessary to place the system in good operating condition are complete.

(g) The Owner shall furnish transportation and such labor as may be necessary for packaging and placement of the equipment. Re-installation and checkout charges may be negotiated with XDS.

9. LIABILITY FOR INJURY OR DAMAGE

XDS shall be liable for any injury to the Owner's personnel or damage to the Owner's property arising from the use of the equipment maintained by XDS when such injury or damage is due to the fault or negligence of XDS. The Owner shall be liable for any injury to XDS personnel or damage to XDS property when such injury or damage is due to the fault or negligence of the Owner.

10. SPECIFIC CONTRACT COMMITMENTS

No representations or statements made by any representative of XDS which are not stated herein shall be binding. The provisions hereof constitute the entire Agreement between the parties with respect to the equipment and its maintenance. The terms and conditions of this Agreement supersede those of all previous agreements between the parties with respect to the equipment covered by this Agreement.

APPENDIX A

EQUIPMENT LOCATION	ADDRESS	CITY	STATE	ZIP CODE

ITEM	MODEL NO	QTY.	DESCRIPTION	UNIT CHARGE*	TOTAL

*Based on 8 hours, Mon. Through Fri.

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XDS

Supplement to License Agreement for XDS Program Products

Xerox Data Systems, Inc.
701 South Aviation Blvd.
El Segundo, California 90245

Reference:
License Agreement No.:

Name and Address of Customer:

Supplement Date:

Xerox Data Systems, Inc. (XDS) is pleased to confirm your order for licenses for the XDS Program Products and/or related optional materials listed below. XDS hereby grants the Customer nontransferable, nonexclusive licenses to use each of these licensed programs and/or related optional materials in printed form as specified below under the terms of the above numbered License Agreement for XDS Program Products between XDS and the Customer, which is hereby supplemented to include the following:

Program Product List

CPU Type/ Serial No.	CPU Instal-lation No.	Program/ Material	Estimated Ship Date	Prog. Service Classifi-cation	Charges	
					Single	Monthly

The CPU serial number, corresponding to the CPU installation number, will be available upon request following shipment of the CPU.

Under the License Agreement for XDS Program Products, the Customer has agreed that until that Agreement is specifically terminated by the Customer upon three months' prior written notice to XDS, the terms of that Agreement as amended will take precedence over the terms of any present or future order from the Customer for licenses. The Customer has further agreed that his acceptance of future delivery of any licensed program or related optional material is conclusive evidence of his agreement that the license for such licensed program or related optional material is governed by the terms of that Agreement as amended.

The provisions of the above numbered license agreement allowing XDS to cancel on six months' notice are not applicable to any single charge program licenses listed above. Single charge program licenses will be for a term equal to the term of the computer installation (CPU) to which the license applies or 10 years from the estimated shipment date, whichever occurs first.

Accepted by:
Xerox Data Systems, Inc.

The Program Product List may be continued on the reverse hereof.

By______________________________
Authorized Signature

____
Name

____
Title

On______________________________
Date

____

____

____

Program Product List (continued)

CPU Type/ Serial No.	CPU Instal-lation No.	Program/ Material	Estimated Ship Date	Prog. Service Classifi-cation	Charges	
					Single	Monthly

XEROX

701 South Aviation Boulevard
El Segundo, California 90245

License Agreement for Program Products

Name and Address of Customer:

License Agreement No.:

Xerox Data Systems, (XDS) a Division of Xerox Corporation by its acceptance of this Agreement by signature at its Regional office or Headquarters, agrees to grant and the Customer agrees to accept on the following terms and conditions nontransferable and nonexclusive licenses to use the Program Products including basic material (together referred to as licensed programs) and related optional materials (optional materials) ordered by the Customer, subject to written confirmation by XDS.

TERM

This Agreement is effective from the date on which it is accepted by XDS and shall remain in force until terminated by the Customer upon one month's prior written notice, or by XDS as provided below.

The minimum use period for each license under this Agreement is one month from the commencement of monthly charges. Any license may be discontinued by the Customer at the conclusion of the minimum use period or any time thereafter, upon one month's prior written notice. XDS may discontinue any license or terminate this Agreement if the Customer fails to comply with any of the terms and conditions of this Agreement, or as provided in the Section of this Agreement entitled "Patent and Copyright Indemnification." Notice of discontinuance of any program license will be notice of discontinuance of any license for optional material obtained in connection with such program license. Notice of discontinuance of any or all licenses shall not be considered notice of termination of this Agreement unless that is specifically stated.

LICENSE

Each program license granted under this Agreement authorizes the Customer to use the licensed program in any machine readable form on a central processing unit or units in a single location designated by location number and its associated units (together referred to as CPU) or on the CPU designated under another then-current license for the identical Program Product. Each optional material license granted under this Agreement authorizes the Customer to use the optional material in any machine readable form on the designated CPU or on the CPU designated under another then-current license for the identical Program Product. A separate license is required for each CPU on which the licensed program and/or optional materials in any machine readable form will be used, provided, however, that the license granted under this Agreement for the designated CPU shall be temporarily transferred to (1) one back-up CPU if the designated CPU is inoperative due to malfunction, or during the performance of preventive maintenance, engineering changes, or changes in features or model, until the designated CPU is restored to operative status and processing of the data already entered into the back-up CPU is completed, and (2) to one other CPU for assembly or compilation of the licensed program if the specifications of the designated CPU are such that the licensed program cannot be assembled or compiled on the designated CPU. For purposes of this Agreement, use is defined as copying any portion of the licensed program's and/or optional material's instructions or data from storage units or media into the CPU for processing. Licenses granted under this Agreement authorize the Customer to utilize licensed programs and/or optional materials, in printed form, in support of the use of such licensed programs and/or optional materials in machine readable form.

This Agreement and any of the licenses, programs or materials to which it applies may not be assigned, sub-licensed or otherwise transferred by the Customer without prior written consent from XDS. No right to print or copy, in whole or in part, the licensed programs or optional materials is granted hereby except as hereinafter expressly provided.

CHARGES

Monthly charges are subject to change by XDS upon three months' written notice to the Customer. If the monthly charge is increased for any program license, the Customer may discontinue it upon one month's written notice to XDS; otherwise the new charge will become effective.

Monthly charges will commence one month after shipment of the licensed program to the Customer, provided, however, charges will not commence on a Saturday or Sunday. Monthly charges will be invoiced in advance and will be payable within thirty days after the date of invoice. Charges for a partial month's use will be prorated based on a thirty-day month.

Certain licensed programs may be subject to an initial charge in addition to monthly charges or a single charge per license period in lieu of monthly charges. Initial and single charges are subject to change without notice.

There shall be added to any charges under this Agreement amounts equal to any taxes, however designated, levied or based on such charges or on this Agreement or the licensed programs or optional materials or their use, including state and local privilege or excise taxes based on gross revenue, and any taxes or amounts in lieu thereof paid or payable by XDS in respect of the foregoing, exclusive, however, of personal property taxes assessed on the licensed programs or optional materials and taxes based on net income.

LICENSE REDESIGNATION

The Customer may notify XDS of his intention to redesignate the CPU on which a licensed program and optional materials are to be used. The redesignation will be effective upon the date specified in an amendment to this Agreement furnished to the Customer by XDS entitled Confirmation of Change in Designated CPU.

ADDITIONAL LICENSES

Under this Agreement the Customer may, from time to time, order additional licenses for a previously licensed program and/or optional materials. These orders will be subject to acceptance by XDS under this Agreement and to the terms and conditions then in effect. Orders for additional licenses should reference this Agreement by number. XDS will confirm such orders and grant additional licenses by Supplements to this Agreement.

BASIC MATERIALS

Program licenses granted under this Agreement will govern any basic materials, in machine readable or printed form, provided by XDS in the quantities specified for each program license, and any additional copies in printed form licensed from XDS at the charges in effect at the time of their shipment.

RELATED OPTIONAL MATERIALS

For certain licensed programs XDS will offer to license related optional materials, under this Agreement or under a separate agreement, provided, however, that optional materials will only be available to Customers who have licensed the programs to which such optional materials apply. Optional materials will be provided by XDS in the quantities specified for each optional materials license. Any additional copies in printed form may be licensed at charges in effect at the time of their shipment.

PROGRAMMING SERVICES

For specified licensed programs, XDS will provide programming services after delivery, without additional charge, to correct licensed program errors and issue corrected releases. However, XDS does not guarantee service results or represent or warrant that all errors will be corrected.

The Programming Service Classification of each licensed program will be specified by XDS in the Program Product List for each license. The Programming Service Classification of any licensed program may be changed by XDS upon six months' notice except as provided in the section of this Agreement entitled "Patent and Copyright Indemnification." Some reclassifications may constitute a discontinuance of services.

The Programming Service Classifications are:

Class 1

When the Customer encounters a problem which XDS field diagnosis indicates is caused by a defect in a current unaltered release of the licensed program, XDS will (1) if the licensed program is inoperable, apply a temporary fix or make a reasonable attempt to develop an emergency by-pass, and (2) prepare a Software Improvement or Difficulty Report (SIDR) and submit it to an XDS Central Programming Service location.

XDS Central Programming Service will respond to any problem caused by a defect in a current unaltered release of the licensed program by issuing a temporary fix to the originator of the SIDR and/or issuing corrected code or notice of availability of corrected code. Corrections will be incorporated into new releases of the licensed program which will be made available to the Customer by XDS. Any other programming services or assistance will be provided at a charge.

Class 2

When The Customer encounters a problem which his diagnosis indicates is caused by a licensed program defect, the Customer may submit an SIDR to an XDS Central Programming Service location.

XDS Central Programming Service will respond to any problem caused by a defect in a current unaltered release of the licensed program by issuing a temporary fix to the originator of the SIDR and/or issuing corrected code or notice of availability of corrected code. Corrections will be incorporated into new releases of the licensed program which will be made available to the Customer by XDS. Any other programming services or assistance will be provided at a charge.

Class 3

Programming services or assistance will be provided at a charge. Central Programming Service will not be provided, except for corrections applicable to SIDR's received prior to the date Class 3 becomes effective for a licensed program previously assigned Class 1 or Class 2.

XDS shall have the right to make additional charges for any additional effort required to provide programming services resulting from Customer use of other than a current unaltered release of the licensed program.

PERMISSION TO COPY OR MODIFY LICENSED PROGRAMS

The Customer shall not copy, in whole or in part, any licensed programs or optional materials which are provided by XDS in printed form under this Agreement. Additional copies of printed materials may be licensed from XDS at the charges then in effect.

Any licensed programs or optional materials which are provided by XDS in machine readable form may be copied, in whole or in part, in printed or machine readable form, for use by the Customer with the designated CPU, to understand the contents of such machine readable material, to modify the licensed program as provided below, for back-up purposes as provided in the section of this Agreement entitled "License," or for archive purposes, provided, however, that no more than five printed copies and five machine readable copies will be in existence under any license at any one time without prior written consent from XDS other than copies resident in the designated CPU itself and copies created and used solely for checkpoint and/or restart purposes. The original, and any copies of licensed programs and/or optional materials, in whole or in part, which are made by the Customer shall be the property of XDS.

If the original or any copy of the licensed program or optional materials will be kept at other than the location of the designated CPU, the Customer will notify XDS in writing of a designated location for the original or copy. However, the Customer may transport or transmit a copy of the original of any licensed program to another location when the license is temporarily transferred as provided in the section of this Agreement entitled "License," provided the copy or the original is destroyed or returned to its designated location when the period of temporary transfer is concluded and the license reverts back to the designated CPU.

The Customer may modify any licensed program and/or optional material, in machine readable form, for his own use and merge it into other program materials to form an updated work, provided that, upon discontinuance of the license for such licensed programs, the licensed program and optional material supplied by XDS will be completely removed from the updated work and dealt with under this Agreement as if permission to modify had never been granted. Any portion of the licensed program or optional material included in an updated work shall be used only on the designated CPU except during a period of temporary transfer as provided in the section of this Agreement entitled "License," and shall remain subject to all other terms of this Agreement.

The Customer agrees to reproduce and include XDS's restrictive proprietary notice on any copies, in whole or in part, in any form, including partial copies in modifications, of licensed programs or optional materials made hereunder in accord with the restrictive proprietary notice instructions to be provided by XDS.

PROTECTION AND SECURITY

The Customer agrees not to provide or otherwise make available any licensed program or optional material, including but not limited to flow charts, logic diagrams and source code, in any form, to any person other than Customer or XDS employees without prior written consent from XDS, except during the period any such person is on the Customer's premises with the Customer's permission for purposes specifically related to the Customer's use of the licensed program or optional materials.

PATENT AND COPYRIGHT INDEMNIFICATION

XDS will defend at its expense any action brought against the Customer to the extent that it is based on a claim that licensed programs or optional materials, used within the scope of the license hereunder, infringe a copyright in the United States or a United States patent; and subject to the limitation of liability stated herein, XDS will pay any costs, damages, and attorney fees finally awarded against the Customer in such action which are attributable to such claim, provided that the Customer notifies XDS promptly in writing of the claim and XDS may fully participate in the defense and/or agrees to any settlement of such claim. Should the licensed programs or optional materials become, or in XDS's opinion be likely to become, the subject of a claim of infringement of a copyright or a patent, XDS may procure for the Customer the right to continue using the licensed programs or optional materials, or replace or modify them to make them noninfringing. If neither of the foregoing alternatives is reasonably available to XDS, then XDS may discontinue the licensed program and/or optional materials upon one month's written notice to the Customer. If, however, the licensed program and/or optional materials is not the subject of a claim of copyright infringement, the Customer may notify XDS in writing during the one month after XDS's notice of discontinuance that the Customer elects to continue to be licensed with respect to the licensed program or optional materials until there has been an injunction or the claim has been withdrawn, and agrees to undertake at the Customer's expense the defense of any action against the Customer and to indemnify XDS with respect to all costs, damages, and attorney fees attributable to such continued use after such notice is given to XDS; it being understood that XDS may participate at its expense in the defense of any such action if such claim is against XDS. Upon XDS's written notice of discontinuance to the Customer, a licensed program with Programming Service Classification 1 or 2 will be changed to Programming Service Classification 3. XDS shall have no liability for any claim of copyright or patent infringement based on (1) use of other than a current unaltered release of the licensed program or optional materials available from XDS if such infringement would have been avoided by the use of a current unaltered release of the licensed program or optional materials available from XDS, or (2) use or combination of the licensed program or optional material with non-XDS programs or data if such infringement would have been avoided by the use or combination of the licensed program or optional material with other programs or data. The foregoing states the entire liability of XDS with respect to infringement of any copyrights or patents by the licensed programs or optional programs or optional materials or any parts thereof.

RESPONSIBILITIES OF THE PARTIES

XDS will publish design objectives and estimated availability dates for licensed programs which it announces. However, XDS does not represent or warrant that such design objectives or estimated availability dates will be met.

XDS will publish Program Product Specifications for each licensed program with Programming Service Classification 1 or 2 as the licensed program is included in the library.

XDS will provide a functional description of each licensed program with Programming Service Classification 3 as it is included in the library.

The Customer shall be exclusively responsible for the supervision, management and control of his use of the licensed programs, and/or optional materials, including but not limited to: (1) assuring proper machine configuration, program installation, audit controls and operating methods, (2) establishing adequate back-up plans, based on alternate procedures and/or based on access to qualified programming personnel to diagnose, patch, and repair licensed program defects, in the event of a licensed program malfunction and, (3) implementing sufficient procedures and checkpoints to satisfy his requirements for security and accuracy of input and output as well as restart and recovery in the event of a malfunction.

The Customer agrees that he will take appropriate action by instruction, agreement, or otherwise with his employees or other persons permitted access to licensed programs and/or optional materials to satisfy his obligations under this Agreement with respect to use, copying, modification, and protection and security of licensed programs and optional materials.

DELIVERY

When available from the Library, licensed programs will be shipped to customers generally within one month after confirmation of order, subject to conditions beyond XDS's control, unless the Customer requests a later delivery date. Announced licensed programs will be included in the Library in accordance with XDS's estimated availability date for each licensed program. However, XDS does not represent or warrant that shipment or availability dates will be met.

Program storage media (magnetic tapes and disks) will be provided at a charge by XDS if not supplied by the Customer. Licensed programs will be shipped to the Customer without charge.

RISK OF LOSS

If any licensed program or optional material is lost or damaged during shipment, XDS will replace the licensed program or optional material and program storage media at no additional charge to the Customer.

If any licensed program or optional material is lost or damaged while in the possession of the Customer, XDS will replace the licensed program or optional material at a charge for program storage media unless it is provided by the Customer.

DISCONTINUANCE

Within one month after the date of discontinuance of any license under this Agreement, the Customer will furnish XDS a completed XDS Program Product Certificate of Discontinuance certifying that through his best effort, and to the best of his knowledge, the original and all copies in whole or in part, in any form, including partial copies in modifications, of the licensed program and any optional material received from XDS or made in connection with such license have been destroyed, except that, upon prior written authorization from XDS, the Customer may retain a copy for archive purposes only.

WARRANTY

Each licensed program with Programming Service Classification 1 or 2 will conform to its published Program Product Specifications when it is shipped to the Customer. Sample data will be shipped with such licensed programs to assure that the Customer has received a valid copy.

Each licensed program with Programming Service Classification 3 will be distributed on an "as is" basis without warranty.

LIMITATION OF LIABILITY

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

The Customer agrees that XDS's liability hereunder for damages including but not limited to liability for patent infringements, but excluding liability for copyright infringements, regardless of the form of action, shall not exceed the charges paid by the Customer for the particular licensed program or optional material involved.

The Customer further agrees that XDS will not be liable for any lost profits, or for any claim or demand against the Customer by any other party, except a claim for patent or copyright infringement as provided herein.

No action, regardless of form, arising out of the transactions under this Agreement, may be brought by either party more than one year after the cause of action has accrued, except that, an action for nonpayment may be brought within one year after the date of last payment.

In no event will XDS be liable for consequential damages even if XDS has been advised of the possibility of such damages.

GENERAL

The terms of this Agreement may be modified by XDS upon six months' written notice to the Customer, except for the terms and conditions which relate specifically to (1) discontinuance of this Agreement or licenses granted under this Agreement as provided in the section of this Agreement entitled "Term" and the section of this Agreement entitled "Patent and Copyright Indemnification," and (2) charges for licenses granted under this Agreement as provided in the section of this Agreement entitled "Charges." The Customer may terminate this Agreement or discontinue any of the licenses hereunder on the effective date of such modification upon one month's prior written notice to XDS; otherwise, such modification shall be effective.

The term "this Agreement" as used herein includes any future written amendments, modifications or supplements made in accordance herewith.

The terms of this Agreement will take precedence over the terms of any present or future order from the Customer for any licenses hereunder. The Customer agrees that his acceptance of future delivery of any licensed program or optional material from XDS is conclusive evidence of his agreement that the license for such program or optional material is governed by the terms of this Agreement.

If any of the provisions, or portions thereof, of this Agreement are invalid under any applicable statute or rule of law, they are to that extent to be deemed omitted.

The customer's remedies in this agreement are exclusive.

The customer acknowledges that he has read this agreement, understands it and agrees to be bound by its terms and, further, agrees that it is the complete and exclusive statement of the agreement between the parties, which supersedes all proposals oral or written and all other communications between the parties relating to the subject matter of this agreement.

This Agreement will be governed by the laws of the State of California.

	Accepted by:
____________________ **Customer**	Xerox Corporation
By ____________________ **Authorized Signature**	By ____________________ **Authorized Signature**
____________________ **Name**	____________________ **Name**
____________________ **Title**	____________________ **Title**
____________________ **Date**	____________________ **Date**

APPENDIX I

Appendix I

STAFFING REQUIREMENTS FOR CONVERSION

Preliminary estimation of staff allocation during conversion is as follows (based on 40 hours/week):

Conversion and Testing[1]	20 man-weeks
Training (minimum)	6 man-weeks
Minimum Conversion Effort	26 man-weeks

Presuming a contract is signed by mid-February and that two full-time staff members are available for conversion, then there are 32 man-weeks available. However, some effort must be devoted to maintenance programming, and additional pre-installation training is certainly desirable. Should a delay occur in execution of the contract or should unforseen difficulty occur in the conversion effort, the six man week excess could rapidly disappear. It is for these reasons, as well as others outlined in Section 6.7.3, that immediate steps should be taken to add another qualified COBOL programmer to the Computing Center staff.

---

(1) Based on responsibility for conversion and testing of 25% of existing programs and partial testing responsibility for the remaining 75% of existing programs.

APPENDIX J

Appendix J

EXPECTED TERMINAL GROWTH PATTERN

Timesharing growth at several universities has been explosive. At Andrews University a more gradual growth is expected due to several inhibiting factors:

- Limited administrative programming staff (this could be modified by cost-benefit studies).
- Limited research effort (although research efforts are presently increasing).
- Limited initial funding of terminal devices.
- Limited efforts, to date, to sell outside services (but this can be changed in a short time).

The following projection (Figure 1) is tentative but probably conservative. Each of the above factors has been considered. It was deemed unrealistic to attempt to project growth beyond the fifth year. For this projection, no attempt has been made to identify the type of terminal device required at each location.

The weighted estimate was developed by dividing the listed departments and agencies into three groups. Each group was assigned a weighting factor by which three weighted subtotals were calculated. The unweighted estimates are offered as valid individual growth patterns; the weighted sum is submitted as a moderately conservative estimate of aggregate terminal growth during the first three years after installation. It is expected that the growth rate will decline and that the final estimate may be nearly the final census.

Location	Number of Terminals Required Time Since System Installation (years) 1	3	5
Mathematics Department	2	3	3
Physics Department	2	3	3
Chemistry Department	1	1	1
Biology Department	1	1	1
Science Complex (General)	3	3	3
Business Administration Departments	1	2	2
Education Department	1	2	3
Home Economics/Nursing Department	1	1	1
Physical Education Department	1	1	1
Computing Center (Programming)	2	2	2
Computing Center (General)	3	3	3
MCST (replacement and growth)	2	3	4
Security Office	1	1	1
Laboratory School	1	1	2
Library	0	2	5
Business Office	0	3	5
Registrar	0	2	3
Lake Union Herald	1	1	1
Lake Union Conference	0	3	5
Dormitory Complex	0	2	4
College Wood Products	0	0	1
Bindery	0	0	1
Bookstore	0	2	2
Grocery Store	0	2	2
Lake Union Academies	2	3	5
Food Services	1	1	1
Berrien County Intermediate School District	1	1	2
Benton Harbor-St. Joseph Schools	2	4	6
Heathkit	3	4	5
Other Commercial Services	2	4	6
Total Estimate	34	61	84
Weighted Estimate	22	43	56

Figure 1

APPENDIX K

(Intentionally Omitted)

APPENDIX L

Xerox Corporation
Traveler's Building, 13th Floor
26555 Evergreen
Southfield, Michigan 48076
313 353-4200

4 January 1973

Mr. Leroy H. Botten
Director, Computer Center
Andrews University
Berrien Springs, Michigan 49104

Dear Mr. Botten:

This addendum has been prepared for review by the Andrews Selection Committee. The prices are firm for a period of sixty days. Should your selection process extend beyond this period, minor adjustments may be required. Xerox remains available to assist in further defining the equipment that best meets the needs of Andrews University. Should substantial equipment changes be necessary, minor adjustments in the proposed cost of conversion services may be necessary.

We welcome the opportunity to discuss or clarify any aspect of this addendum at the convenience of Andrews representatives.

Very truly yours,

XEROX CORPORATION

George D. O'Leary
District Manager

Attachments

mc

I. INTRODUCTION

This addendum to the Xerox proposal dated September 8, 1972 has been written to present a new alternative in equipment, procurement method and resulting costs. In addition, a new more specific proposal for conversion services is presented. The changes in equipment have resulted from our jointly re-evaluating the needs of Andrews University. The new proposal to assist Andrews in its conversion effort was developed by the Applications Systems Division of Xerox after a second review of existing programs and systems and a review of Andrews resources. In the near future, a complete and detailed conversion plan should be developed to assure a smooth and orderly transition to your new equipment. We welcome the opportunity to assist Andrews in preparing this plan and will do so at your convenience.

In addition, the following reference information has been added:

Section V	Power/Heat Estimates
Section VI	Floor Plan
Section VII	Sample Standard Contracts
Section VIII	Memory Expansion Options

II. HARDWARE CONFIGURATIONS

Introduction

Xerox and Andrews have explored a substantial number of possible hardware configurations for consideration. From these, Xerox has selected one for presentation in this addendum.

This configuration represents a superior solution to the long range needs of Andrews University. This configuration permits a UTS operating system that contains a richer set of processing languages and installation control features. As Andrews University experiences its internal growth in the number of time sharing users and begins to service other organizations, this new hardware/software approach will prove to be the most economical long range solution.

The general needs as Xerox understands them are as follows:

1. A system capable of performing concurrent batch and time-sharing for twenty-four terminal users.
2. A system capable of handling a complete set of unit record peripherals (such as card readers, card punches, line printers, etc.) on completely automatic basis.
3. A system capacity to handle slow speed - low density nine track magnetic tapes with the ability to move to faster units with correspondingly higher recording densities. Growth options are presented in the Appendix (Section II).
4. An initial capacity to store approximately fifty million bytes of data on-line, with the ability to substantially increase this capacity if and when required. Expansion capabilities are presented in the Appendix (Section III).

Configuration and Cost Proposal

The equipment below has resulted from extensive contact with members of the Andrews Selection Committee.

CPU Sub-System

Model	Description	Gross Purchase Price	Educational Discount	Net Purchase Price
8310C	Sigma 6 CPU (64K Words)	286,000	57,200	228,800
	192 KB Memory	N/C		
	Multiplexor I/O Processor	N/C		
	Four Byte Interface	N/C		
	Decimal Arithmetic	N/C		
	Memory Map with Access Protection	N/C		
	Memory Write with Protection	N/C		
	Two Real-Time Clocks	N/C		
	Two Register Blocks	N/C		
	Power Fail-Safe	N/C		
	External Interface	N/C		
	Dual Access (2-Part)	N/C		
8318	Floating Point Arithmetic	2,500	5,000	20,000
8321	Interrupt Control Chassis	2,200	440	1,760
8322	Priority Interrupt, 2 Levels	350	70	280
8375	IOP Expansion Feature	17,500	3,500	14,000
			Sub-Total	264,840

Magnetic Tape Sub-System

Model	Description	Gross Purchase Price	Educational Discount	Net Purchase Price
7315	Controller plus one Transport	28,000	2,800	25,200
7316	Add-on Tape Transport	12,000	1,200	10,800
			Sub-Total	36,000

Model	Description	Gross Purchase Price	Educational Discount	Net Purchase Price
Unit Record Sub-System				
7122	Card Reader (400 CPM)	16,000	1,600	14,400
7165	Card Punch (100 CPM)	19,600	1,960	17,640
7441	Line Printer (1100 LPM)	46,000	4,600	41,400
			Sub-Total	73,440
Removable Disk Pack Sub-System				
7240	Controller	20,000	2,000	18,000
7242	Dual Spindle Drive	25,000	2,500	22,500
			Sub-Total	40,500
7012	Operators Console	6,000	600	5,400
Communications Sub-System				
7612	Timing Module	250	50	200
7630	Controller plus 8 Lines	14,000	2,800	11,200
7631	Eight Line Expansion (2 requested)	11,600	2,320	9,280
			Sub-Total	20,680
Random Access Device Sub-System				
7231	Extended Performance RAD Controller	14,000	2,800	11,200
7232	Extended Performance RAD (6.2 MB)	50,000	20,000	30,000
7235	Extended Width Interface Feature	2,500	500	2,000
			Sub-Total	43,200
	Add-On Equipment Sub-Total			219,220
	Configuration TOTAL	596,000	111,940	484,060

Cost Summary and Comparison

Installment Purchase Seven Year Plan

Monthly Installment Payments	7,067.28
Monthly Maintenance	3,013.60
Total Monthly Cost	10,080.88
Total Seven Year Cost	846,793.92

One Year Lease of Selected Peripherals Plan

One Year Lease Costs For

7122 Card Reader	360.00
7165 Card Punch	441.00
7441 Line Printer	1,035.00
	1,836.00

Monthly Installment Payments*	5,995.05
Monthly Maintenance	2,650.25
Total Monthly Cost	10,481.30
Total Annual Cost	125,775.60

* Over seven years for the remainder of the system.

Lease to Purchase Conversion For Years Two-Seven

Unit Record Sub-System	
Purchase Price	73,440.00
Less Conversion Credit	-8,812.80
Net Purchase Price	64,627.80
Six Year I. P. Factor	.0166
Monthly Payment	1,072.81
Remainder of System	5,995.05
	7,067.86
Maintenance	3,013.60
Monthly Cost Years Two-Seven	10,081.46
Total For Six Years	725,865.12
First Year Cost	125,775.60
Total Seven Year Cost	851,640.72

III. CONVERSION

Introduction

Of central concern in the installation of any new data processing equipment is the manner in which existing systems and programs will be converted to the new system.

In order to minimize the risks associated with conversion, Xerox formed a special department. This department (Applications Systems Division) was initially restricted to internal Xerox projects. After having perfected both the technical skills/tools and the necessary management techniques, their services have been made available to Xerox customers. These services are available to only those converting to Xerox equipment. The services are defined by an agreement which specifies in detail the nature of the work to be performed and the fees (if any) that are to be charged.

When the statement of services to be performed have been defined, the Agreement is signed for a fixed fee. Thus, Andrews University knows the exact amount of funds to allocate and the participation of the Xerox and the University Staff is clearly differentiated.

The Agreement also specifies the schedule allocated for Xerox participation. In general, the available staff is sufficient to meet even the most demanding schedule. The lead time for hardware delivery is usually more than sufficient for most conversion efforts.

Options and Estimated Fees

Section IV of the Appendix contains the proposal for Xerox services at Andrews University. Several options based on level of participation are defined in detail in this proposal. The fee structure is based on an estimated net sale price of the equipment of about $484,000. Should this value change significantly, the fee structure must be requoted. All fees are subject to final negotiations concerning the division of effort between Xerox and Andrews University. The options and estimated fees are outlined below:

Alternative One - Clean Compile

This alternative will be provided by Xerox at no cost to Andrews. In general, it involves converting your existing programs to Xerox Syntax, in a state suitable for the start of testing.

Alternative Two - Basic Case Test (All Programs)

The estimated fee is $8,600. This alternative is the most complete level of service and would permit Andrews University to pass through the conversion effort with a minimum of involvement.

Alternative Three - Selected Base Case Test

The estimated fee is $1,300. In this alternative, Xerox would take primary responsibility for those systems outlined in the proposal with Andrews assuming responsibility beyond the clean compile stage for all others.

APPENDIX

SECTION I

CENTRAL PROCESSOR MAINTENANCE COSTS

8310C	Sigma 6 CPU with No Cost Options and 64K Memory	1,792.00
8318	Floating Point Arithmetic Unit	103.00
8321	Interrupt Control Chassis	30.00
8322	Priority Interrupt, 2 Levels	N/C
8375	IOP Expansion Feature	98.00
		2,023.00

SUMMARY OF MAINTENANCE COSTS - TOTAL SYSTEM

8310C	Sigma 6 with Options	2,023.00
Add-On Devices		1,921.00
	Gross Monthly Cost	3,944.00
	Less Discount	930.40
	Total Net Monthly Maintenance Cost	3,013.60

SUMMARY OF MAINTENANCE COSTS

EXCLUDING UNIT RECORD SUBSYSTEM

8310C	Sigma 6 with Options	2,023.00
Add-On Devices less unit record subsystem		1,362.00
	Gross Monthly Cost	3,385.00
		734.75
		2,650.25

MAINTENANCE COST - ADD ON DEVICES

Model	Description	Monthly Maintenance	
Magnetic Tape Sub-System			
7315	Magnetic Tape Control and Transport	286	
7316	Add-on Tape Transport	180	
	Sub-Total	466	466
Unit Record Sub-System			
7122	Card Reader	127	
7165	Card Punch	140	
7441	Line Printer	292	
	Sub-Total	559	559
Disk Pack Storage Sub-System			
7240	Disk Controller	104	
7242	Dual Spindle	281	
	Sub-Total	385	385
7012	Operators Console		48
Communication Sub-System			
7612	Timing Modules	NC	
7630	Communications Controller plus 8 Lines	47	
7631	8 Line Expansion (two required)	62	
	Sub-Total	109	109

Drum Storage Sub-System

7231	RAD Controller		73	
7232	6.3 MB RAD Storage		265	
7235	Extended Width Feature		16	
		Sub-Total	354	354
		TOTAL		1,921

SECTION II

II. MAGNETIC TAPE OPTIONS

Qty.	Model	Gross Pruchase	Discount	Net Purchase	Expansion Charge
1	7315	28,000	2,800	25,200	Proposed In All Alternatives
1	7316	12,000	1,200	10,800	
			Total	36,000	
1	7330	28,400	2,840	25,560	200
1	1038	4,000	400	3,600	200
1	7332	18,500	1,850	16,650	50
1	7322	12,000	1,200	10,800	50
			Total	56,610	500
1	7330	28,400	2,840	25,560	200
2	7332	37,000	3,700	33,300	100
			Total	58,860	300
1	7330	28,400	2,840	25,560	200
2	7333	51,700	5,170	45,590	100
1	1039	2,500	250	2,250	60
			Total	73,400	360

Model	Description
7330	Magnetic Tape Controller 1600 BPI
1038	800 BPI Option for 1600 BPI Controller
7332	800 BPI, 75 IPS Tape Transport (60 KB)
7332	1600 BPI, 75 IPS Tape Transport (120 KB)
7333	1600 BPI, 150 IPS, Tape Transport (240 KB)
1039	Extended Width Interface

SECTION III

III. DISK EXPANSION CAPABILITIES

Qty.	Model	Gross Purchase	Discount	Net Purchase	Expansion Charge
1	7246	15,000	1,500	13,500	780
1	7242	25,000	2,500	22,500	1,040
1	7242B	45,000	4,500	40,500	2,080

Model	Description
7246	Single Spindle 24.5 MB Removable Disk Drive
7242	Dual Spindle 49.1 MB Removable Disk Drive
7246	Four Spindle 98.3 MB

Note – Disk Controller was not presented here as each controller may control up to eight (8) spindles in any combination of the above devices.

SECTION IV

ANDREWS UNIVERSITY

CONVERSION PROPOSAL

BY

XEROX

COMMERCIAL SYSTEMS DEPARTMENT

NOVEMBER 6, 1972

✓

1.0 INTRODUCTION

Xerox is pleased to offer the services of its Commercial Systems Department to convert Andrews University Administrative Computer Systems COBOL programs to Xerox ANS COBOL, and BAL subroutines to Xerox META-SYMBOL.

Originally created to convert the Xerox Corporation computer complex to XDS equipment, the Commercial Systems Department provides Andrews with a simplified and efficient approach to the conversion of its data processing applications. Utilizing a sophisticated group of conversion aids and operating in a terminal environment, the Commercial Systems team of specialists can implement conversions in a smooth and effective manner.

The specialized skills, knowledge and resources of Commercial Systems provides Andrews University with the following benefits:

> Your programming staff can be relieved of a time consuming and non-productive conversion assuring that maximum effort is directed to the development of new systems and timely maintenance of present systems.
>
> Disruption of present operations is minimized.
>
> Reductions in both the cost and the elapsed time to complete the conversion can be achieved.
>
> Risks associated with any delays and their costly impact on Andrews will be significantly reduced.

This proposal represents a summary of our analysis of your existing programs and procedures conducted on October 19th by one of our marketing specialists, and through conversations with Mr. LeRoy H. Botten and Don Inglemeir. Included are the alternate approaches that Xerox offers to you as our involvement in the total conversion effort. We will be happy to discuss any additional alternatives to the conversion task that seem appropriate and look forward to

1.0 INTRODUCTION Con't.

the opportunity of working with you in developing a smooth and efficient conversion plan utilizing the resources of both Xerox and Andrews to best advantage.

2.0 SCOPE OF EFFORT

This proposal is specifically addressed to the 289 COBOL programs and 11 BAL subroutines which, according to Andrews' documentation, are currently in the active or production stage on the IBM 360/22. It does not include the few RPG programs that were encountered nor any other COBOL or BAL programs that are not listed in Appendix A.

If there are any discrepancies in the program counts they should be brought to the attention of Xerox before any agreement is finalized as it may require an adjustment to the conversion costs.

During the conversion we may find it necessary to make system changes such as changing file labels, creating overlays, etc. to conform to the differences which may arise from the change in operating systems. However, in no case will such changes, either desirable or necessary, cause any differences in the final output of your system unless you agree that such a change is permissible.

One of the reasons for the success of the Commercial Systems Department in converting new customer installations is our ability to perform straight conversion tasks at a lower cost than the customer can do themselves. The reason for this is our experience, Sigma on-line programming capabilities and conversion aids developed in the past three years. Generally speaking, the success of a straight conversion does not require detail knowledge of the applications themselves, but rather knowledge of the targeted hardware and software, which our people know best.

Based on this background we are offering Andrews three alternatives for your consideration. Alternative One is to clean compile all your COBOL and BAL programs listed in Appendix A. Alternative Two includes the above task plus base case testing of all programs and their related sorts. Alternative Three offers clean compile of all programs plus base case testing of selected systems and related sorts, with Andrews being responsible for testing the remaining systems and sorts. Each of these is defined in detail on the following pages.

2.1 Alternative One - Clean Compile

With this alternative Xerox is proposing to convert all the COBOL and BAL programs mentioned in Exhibit A of this proposal to a clean compile stage (ready for testing) on a guaranteed, fixed price basis. The programs will be translated, compiled, and debugged until a diagnostic free program (except for warning level diagnostics) is obtained and object modules can be created.

In order to perform the conversion we will require that you deliver up-to-date compiled source listings, the source programs themselves on cards or 800 BPI tape, file layouts and printer layouts for each source program. In addition, any program descriptions, system flows, etc., which you can make available, should also be included.

At the completion of the task we will deliver the converted source programs and final compile listings with the LS, XREF, MAP, and DIAG compiler options plus a write up of any procedural changes that were incorporated in the converted programs.

Under this alternative Andrews will be relieved of much of the unproductive work associated with the program conversion, but will be responsible for all program testing, JCL conversion and file conversion.

2.2 Alternative Two - Base Case Test (all programs)

This alternative includes all the elements of Alternative One plus complete base case testing of the 389 COBOL and 11 META-SYMBOL programs. In addition all related sorts will be converted and tested.

Before testing begins, you must deliver all base case test files, data, control totals, finished reports, and operating instructions that will establish the accuracy of the converted programs. The term "base case" implies an abbreviated file and/or quantity of test data to make the test runs shorter in duration (15 minutes or less on the average) than normal operational runs. It will be Andrews responsibility to create the test data and files. They should be varied enough to assure complete testing of the logic of the programs.

At the end of the conversion effort we will deliver to you executable control decks and system test results showing a match-up of the control totals and finished reports.

Base case testing does not imply any parallel or full process cycle testing. Xerox only guarantees that the converted programs will meet the requirements of the base case tests.

Under this alternative you will be relieved of almost all of the conversion task. Your people will, however, still be the key to the success of the overall conversion in the data they supply us for testing, and in final sign off of the completed systems and implementation to an operational environment. This alternative will include JCL conversion, but you will be responsible for bring the systems up live on your Sigma 9 and bringing the files over from your previous system at time of cut over.

2.3 Alternative Three - Base Case Test (selected systems)

Alternative Three will consist of clean compile (as outlined in Alternative One) of all programs plus base case testing of the following systems and related sorts:

System	# Programs
Accounts Payable	22
Church System	21
Equipment	15
General Ledger	41
Lake Union Address	12
NIDA	20
Payroll	35
Student Records	72
Statements	15
TOTAL	253

All conditions and specifics outlined in Alternative Two for base case testing apply to the above systems.

It will be Andrews responsibility to test the following systems and their related sorts (a total of 136 programs).

Systems

- Alumni Records
- Building and Land
- Cash
- Computing Center Billing
- Chapel
- Check Reconcilation
- Custodian Supplies
- Custodian Labor/Dray
- Daily Checks
- Dun Lists
- FM Radio Station
- Tuition
- Miscellaneous
- Food Service
- Interdepartment Change
- AUCC Inv.
- Institutional Reser.
- Library Periodicals
- Medical Insurance
- Project Donations
- Plant Service
- Teaching Materials
- Test Scoring
- CWP Inventory
- Xerox Charges
- Utility Programs

All specifics outlined in Alternative One for clean compile will apply to the above systems.

2.3 Alternative Three - Con't.

This alternative would allow your staff at Andrews to become involved with "hands on" experience on the new system and familiarity with Xerox ANS COBOL.

3.0 CONVERSION CONTROL

A project leader will be assigned by Xerox to oversee the conversion effort. Working with the local marketing representative, he will be your main contact throughout the conversion in the areas Commercial Systems is involved. It will be his responsibility to handle the collection of information, resolve problems and conduct periodic reviews to appraise you of the conversion progress. We request that you assign a project coordinator to resolve any unanswered questions that might arise; provide an approach selection decision where multiple Xerox alternatives are available in resolving a difference caused by language, hardware or software; and act as an interface between Andrews and Xerox for the conversion effort.

The conversion does not provide for any enhancements or redesign, but where it would be advantageous to the University to change the file storage media from cards to disk or tape, Commercial Systems will consider the improvement. Implementation will depend on the impact to the overall conversion project and be the sole discretion of Xerox.

4.0 PRICE

Alternative One -	-0-
Alternative Two -	$8,600
Alternative Three -	$1,300

Xerox is prepared to provide any of the above alternatives for the prices indicated in order to support you in your installation of a Xerox Sigma 6E computing system. We feel these prices are substantially less than you could find anywhere else for this service because of Xerox's unique capabilities in this area, and from prior experience these prices are lower than what it would cost you to convert yourselves. As mentioned earlier we would be willing to discuss any other alternativo which would seem appropriate. If not accepted by you within 90 days of receipt of this analysis this offer will be withdrawn.

5.0 SCHEDULE

Work schedules, milestones, and completion dates will be determined jointly after acceptance of the order by Xerox. The schedule and a detailed itemization of deliverable items will then be stated in a formal contract. We will be prepared to begin work thirty days after the receipt of the order by Xerox.

6.0 CONVERSION AGREEMENT

After the final terms of the conversion have been agreed upon Andrews University and Xerox will enter into a formal agreement for the conversion effort. The agreement will detail all the tasks previously described and include the following provisions:

6.1 Modifications

Any changes by Andrews University in its programs to be converted by Xerox subsequent to delivery of the programs to Xerox shall be the University's sole responsibility and we shall have no conversion responsibility to include such changes.

6.2 Facilities and Location

All facilities and computer time related to the tasks described shall be the sole responsibility of Xerox and the tasks will be performed in Rochester, New York.

6.3 Acceptance Criteria

Xerox shall consider the effort complete and accepted when all items have been delivered and all tasks described in the agreement have been performed and accepted by Andrews University. You may provide any test problems or additional acceptance criteria as long as the ground rules are established before a formal agreement is made. If after completion of all tasks you do not respond within 30 days with a written description of any problems encountered and the cause of each problem, we will assume you have accepted the task as completed.

6.4 Warranty

Xerox will guarantee that the tasks specified will be performed and meet the standards described in the Agreement. In addition, Xerox assumes responsibility for all Agreement overruns and schedule slippages, except where schedule slippages are caused by failure of Andrews University to deliver required items. The agreed-to price will not be negotiated due to man weeks or machine time overruns on the stated program counts.

6.5 Waivers

No warranties will be made that the converted system will meet any specific performance requirements as this is a function of the original design of the programs and the operating environment the systems will be run under.

In addition, the acceptance and installation of the computer equipment required by Andrews University from Xerox according to a separate contract is not related to the status of the conversion, which will be the subject of the CSD Services Agreement. Any provisions for machine acceptance provided in the normal machine agreement are not changed by the execution of the CSD Services Agreement.

In no event shall Xerox be liable for consequential damages under the CSD Services Agreement.

7.0 DATA

This proposal has been prepared by Xerox based upon data furnished to it by Andrews University.. To the extent that such data is inaccurate, incomplete or subject to an interest in others, Xerox reserves the right to withdraw or amend this proposal.

If a contract should be awarded by Andrews University to Xerox based upon this proposal, the contract shall contain the following provisions: "The service to be performed by Xerox hereunder is dependent upon data to be furnished to Xerox by Andrews University. If such data is inaccurate, incomplete or subject to an interest in others, and such shall cause Xerox to incur additional costs or expend additional time in performance of the service, an equitable adjustment in the

7.0 DATA Con't.

contract price and schedule shall be made. If such data is subject to an interest in others, Andrews University shall hold Xerox harmless from all claims by such others with regard to such data, and shall defend Xerox from such claims at Andrews' expense".

EXHIBIT A

General Ledger

GL0109
GL0072
GL0101
GL0056
GL0080
GL0000
GL0031
GL0032
GL0044
GL0045
GL0050
GL0052
GL0053
GL0065
GL0041
GL0043
GL0068
GL0071
GL0073
GL0074
GL0076
GL0077
GL0078
GL0079
GL0085
GL0090
GL0091
GL0095
GL0096
GL0250
GL0240
GL0103
GL0104
GL0105
GL0106
GL0107
GL0108
GL0115
GL0210
GL0230
GLPOST

NIDA

NI0050
NI0106
NI0109
NI0120
NI0134
NI0155
NI0185
NI0192
NI0203
NI0210
NI0103
NI0109
NI0110
NI0130
NI0135
NI0180
NI0190
NI0200
NI0205
NI0215

Lake Union Address

LU1010
LU1016
LU1018
LU1025
LU1030
LU1040
LU1055
LU1015
LU1017
LU1020
LU1028
LU1035
LU1050

Payroll

PR1205
PR1215
PR1228
PR1235
PR1240
PR1260
PR1300
PR1140
PR1150
PR1160
PR1168
PR1299
PR1176
PR1182
PR1190
PR1194
PR1196
PR1198
PR1210
PR1220
PR1230
PR1236
PR1250
PR1270
PR1104
PR1145
PR1153
PR1165
PR1170
PR1175
PR1180
PR1185
PR1192
PR1195
PR1197

Utility Programs

ZZ0001
ZZ0015
ZZ0030
ZZ1030
ZZ1036
ZZ1101
ZZ1040
ZZ1042
ZZ1044
ZZ1054
ZZ1205
ZZ0010
ZZ0025
ZZ1020
ZZ1035
ZZ1037
ZZ1039
ZZ1041
ZZ1043
ZZ1050
ZZ1055
ZZ1210

Miscellaneous

9 Programs

Church Systems

CR0005
CR0010
CR0020
CR0025
CR0035
CR0042
CR0050
CR0065
CR0071
CR0080
CR0095
CR0007
CR0015
CR0022
CR0030
CR0040
CR0045
CR0060
CR0070
CR0075
CR0085

Equipment

EQ0949
EQ0953
EQ0958
EQ0962
EQ0966
EQ0970
EQ0974
EQ0976
EQ0950
EQ0954
EQ0960
EQ0964
EQ0968
EQ0972
EQ0975

Statements

ST0304
ST0306
ST0308
ST0310
ST0311
ST0312
ST0314
ST0320
ST0322
ST0326
ST0330
ST0331
ST0335
ST0340
ST9999

Project Donations

PD6510

Test Scoring

TS0010
TS0020
TS0025
TS0030

Xerox Charges

XX0640

Plant Service

PS0830
PS0845
PS0840
PS0850

Student Records

SR0950
SR0960
SR1000
SR1022
SR1028
SR1040
SR1056
SR1080
SR1105
SR1113
SR1150
SR1175
SR1216
SR1230
SR1264
SR1280
SR1294
SR1299
SR1301
SR1304
SR1311
SR1322
SR1330
SR1410
SR0951
SR0961
SR1010
SR1026
SR1030
SR1050
SR1057
SR1091
SR1106
SR1119
SR1152
SR1210
SR1220

SR1232
SR1268
SR1292
SR1295
SR1403
SR1302
SR1305
SR1320
SR1323
SR1332
SR1420
SR0952
SR0962
SR1020
SR1027
SR1145
SR1051
SR1062
SR1104
SR1110
SR1130
SR1165
SR1215
SR1226
SR1272
SR1293
SR1298
SR1300
SR1303
SR1310
SR1321
SR1324
SR1402
SR0000
SR1240

Interdepartment Charges

IN0661
IN0664

Institutional Research

IR0010
IR0020

Statements

ST0304
ST0306
ST0308
ST0310
ST0311
ST0312
ST0314
ST0320
ST0322
ST0326
ST0330
ST0331
ST0335
ST0340
ST9999

Test Scoring

TS0010
TS0020
TS0025
TS0030

Tuition

TU0253
TU0256
TU0265
TU0255
TU0260
TU0266

CPU Inventory

WP0005

Medical Insurance

MD0808
MD0810

Cash

CA0290

Alumni Records

AL0015
AL0030
AL0050
AL0095
AL0099
AL0025
AL0040
AL0060
AL0098
AL0110

Daily Checks

DC0010
DC0030
DC0020

Dun Lists

DL0595
DL0598

FM Radio Station

FM0000
FM0005
FM0020
FM0035
FM0055
FM0065
FM0001
FM0010
FM0030
FM0040
FM0060
FM0075

Accounts Payable

AP2200
AP2215
AP2226
AP2255
AP2275
AP2282
AP2290
AP2300
AP2340
AP2350
AP2210
AP2225
AP2235
AP2270
AP2280
AP2285
AP2295
AP2302
AP2320
AP2345
AP2256
AP2310

Building & Land

BA1010
BL2504
BL2510
BL2500
BL2506
BL2512

Chapel

CH5103
CH5110
CH5116
CH5123
CH5106
CH5114
CH5118
CH5130

Computing Center Billing

CCMETER
CC9120
CC9140
CC9110
CC9130
CC9150

Check Reconcilation

CK2105
CK2125
CK2115

Custodian Supplies

CS0615
CS0625
CS0020
CS0630

Food Service

FS0010
FS0015

Teaching Materials

TM0010
TM0015

AUCC Inventory

IV0040
IV0055
IV0065
IV0075
IV0050
IV0060
IV0070
IV0080

Library Periodicals

LI0033
LI0030
LI0040
LI0005
LI0035
LI0050

Custodian Labor/Dray

CU0650
CU0660
CU0670
CU0680
CU0690
CU0655
CU0665
CU0675
CU0685

BAL PROGRAMS

GL0079
TURNNAME
GETCOMMA
DERPAKU
DERBYTU
GLFILE
NTEST
DERXPDU
DERBITU
CBISAM
CALIOO

The following routines will not be converted. The reasons for this are listed beside each routine.

READCARD - Because Sigma is a symbiont system this particular function does not exist.

DERPPNU - Cannot simulate function.

DERUPNO - Cannot simulate function.

GETTIME - Xerox has a similar routine.

PUNCHY - Same as READCARD.

INTERPT - Cannot simulate function.

CHANUPSI - Because of various Sigma features this function is no longer needed.

PROGSORT (SORT SET) - Xerox COBOL has SORT verb, therefore, this routine is no longer needed.

PRINTER - Xerox has the full set of control characters available to COBOL.

STCOMRG - Cannot do directly, but will set up FD to store data.

GETDATE - Xerox has a similar routime.

RECOMRG - Same as STCOMRG.

BAL PROGRAMS Con't.

SIGNCTL2 - Xerox COBOL can perform same function

DERCANU - Xerox has similar function.

DERDMPU - Xerox has similar function.

DTEUPSI - Xerox has similar routine.

DERUPSU - Xerox has similar function.

DERPDUM - Cannot simulate function.

Section V

PRE-INSTALLATION POWER/HEAT ESTIMATES

INSTALLATION NO.	SALES ORDER NO.
CUSTOMER Andrews University	
SYSTEM Sigma 6	DATE: 1/2/73 SHEET 1 OF 1

KEY	UNIT	POWER	KVA	WIRE GA.	CONNECTOR	BREAKER	BTU/HR
1	I/O	& Neutral 120/208 V, 60 HZ, 3-Phase "WYE" & Gnd	8.63	10 AWG	45105*	3P-30A	26,570
2	CPU	" (5-Wire Distribution)	8.63	10	45105	3P-30A	26,570
3	CPU	"	8.63	10	45105	3P-30A	26,570
4	RAD	"	2.18	10	1" Conduit	3P-30A	5,081
5	DISK	"	2.64	12	45105	3P-15A	5,276
6	L.P.	"	5.34	10	45105	3P-30A	14,632
7	CONT	120 V, 60 HZ & Ground	1.08	12	** 2610 (3120)	1P-15A	2,523
8	MTS	"	2.09	10	2610 (3120)	1P-30A	5,058
9	MTM	"	1.66	10	2610 (3120)	1P-30A	4,012
10	C.P.	"	1.22	10	2610 (3120)	1P-20A	2,860
11	C.R.	"	1.08	12	2610 (3120)	1P-15A	2,616
12	KSR	"	.30	Note 1			900
		Totals	43.48			23 Breaker Positions	122,668 =
							10.3 Tons A/C

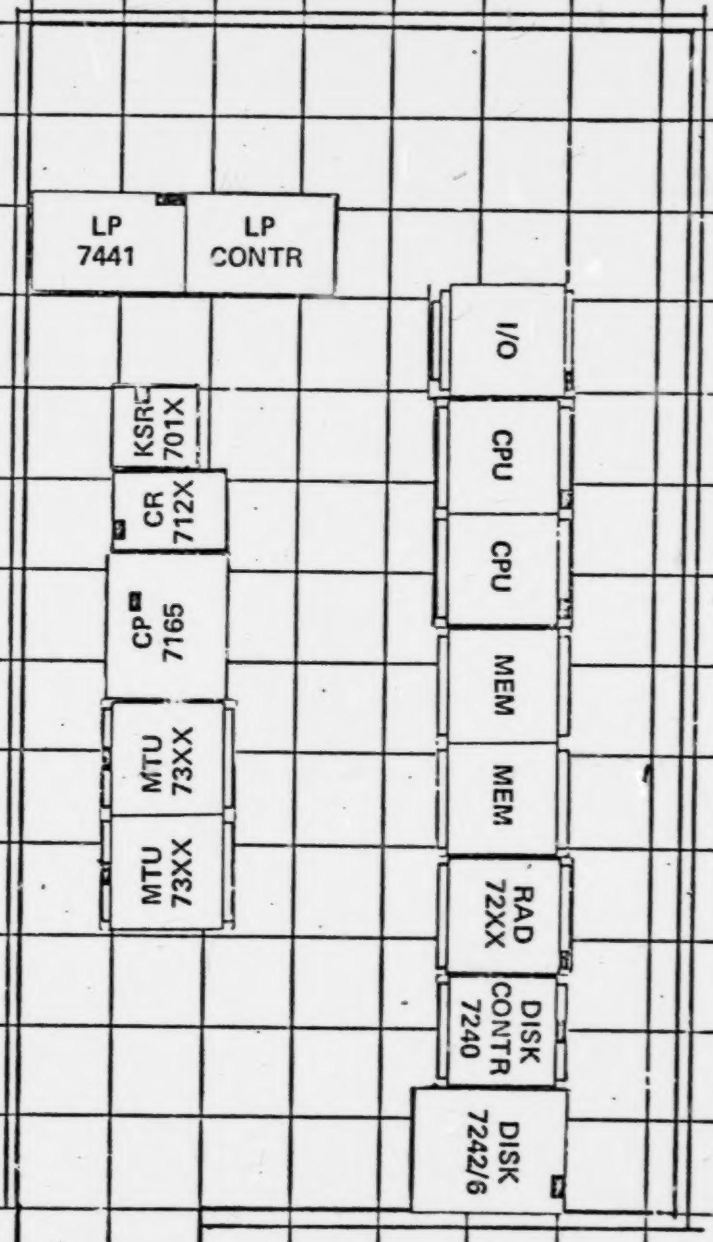
Note 1: Control KSR normally derives power from CPU Power Junction

*: All connectors are H. Hubbell or equivalent

**: 2610 is new model #; 3120 is old model #

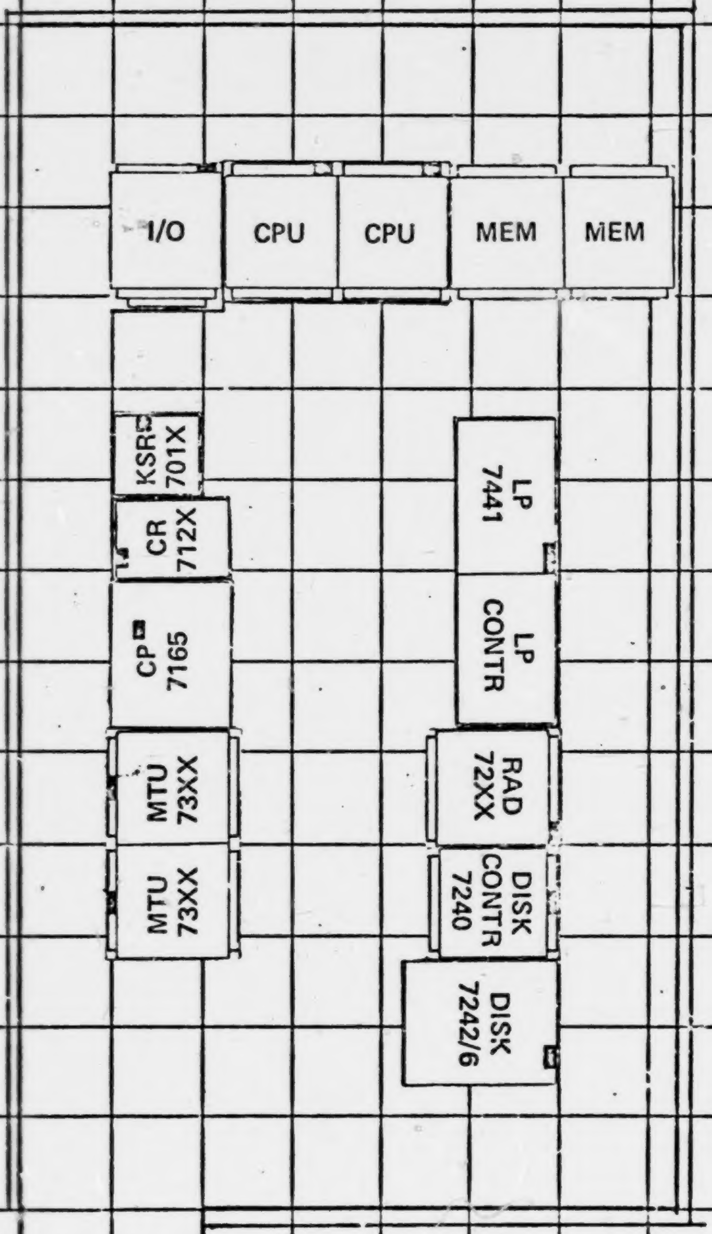
SECTION VI

XEROX **ANDREWS** **Planning Sheet**

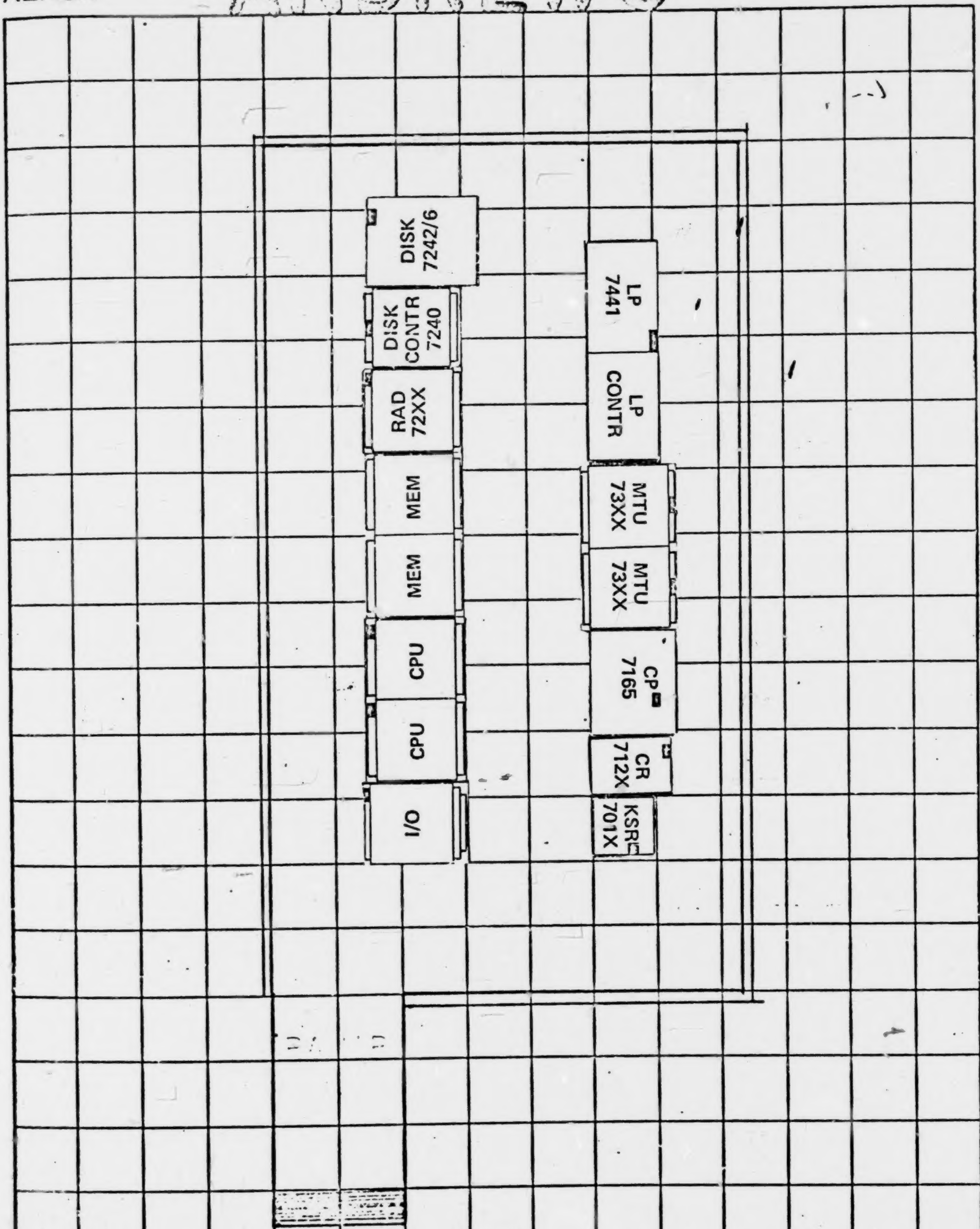

LP 7441
LP CONTR
I/O
KSR 701X
CR 712X
CPU
CPU
CP 7165
MEM
MEM
MTU 73XX
MTU 73XX
RAD 72XX
DISK CONTR 7240
DISK 7242/6

EACH BLOCK EQUAL TO 24 INCHES

XEROX ANDREWS Planning Sheet


I/O
CPU
CPU
MEM
MEM
KSR 701X
CR 712X
CP 7165
MTU 73XX
MTU 73XX
LP 7441
LP CONTR
RAD 72XX
DISK CONTR 7240
DISK 7242/6

XEROX **ANDREWS** **Planning Sheet**


DISK 7242/6
DISK CONTR 7240
RAD 72XX
MEM
MEM
CPU
CPU
I/O
LP 7441
LP CONTR
MTU 73XX
MTU 73XX
CP 7165
CR 712X
KSR 701X

SECTION VII

XDS
Xerox Data Systems

TYPE A

LEASE AGREEMENT

Term 1 year (s)

Lessee ______________________ State of Incorporation ______________________

Street Address ______________________ Equipment Location Street Address ______________________

City ________ State ________ Zip Code ________ City ________ State ________ Zip Code ________

Xerox Data Systems, Inc. (hereinafter called XDS) agrees to lease to the above named Lessee at the above address, and the Lessee agrees to accept for the lease amounts stated herein, XDS computing equipment noted below (excluding Program Products) installed and ready for Lessee's use, together with instructions in the operation of the equipment and maintenance service on the equipment, upon the terms and conditions hereinafter stated in this Agreement.

Item	Model No.	Qty.	Description	Basic Monthly Charge Each	
				Unit Charge	Item Charge
1	7122	1	Card Reader	360	360
2	7165	1	Card Punch	441	441
3	7441	1	Line Printer	1,035	1,035
Sales Price of Equipment $ 73,440				Total: $	1,836

Delivery Date June/July 1973

XDS will provide Maintenance Service on the above equipment in accordance with both Paragraph 6 of this contract and the following

A. Service Hours:

Regular Service Hours will be 8:30 to 5:30 Monday through Friday, excluding holidays and one hour meal period.

Extended Service Hours will be ________ to ________ , ________ through ________ for an additional monthly charge of $________ .

B. Optional Local Service will be provided for an additional monthly charge of $________ .

C. "On-Call" Maintenance will be provided for in accordance with Paragraph 6 of this contract up to an amount not to exceed $________ .

AGREED TO THIS

________ day of ________ 19____

____
Lessee

____
By

____
Title

ACCEPTED THIS

________ day of ________ 19____

XDS Xerox Data Systems
701 South Aviation Blvd., El Segundo, California 90245

____
By

____
Title

Lease Number ________________

1. LEASE TERM

The lease term shall commence when service begins and continue for the number of years shown. After the initial period, the lease will remain in effect until terminated by either party with three months written notice. Upon expiration of the lease term, or extension thereof, Lessee shall return the equipment in good condition with allowance for normal wear and tear.

2. MONTHLY CHARGES

The basic monthly charges shall be payable on the installation date of the equipment for the calendar month in which equipment is first installed and shall be prorated to the end of the month, and thereafter shall be paid for each calendar month on the first day of that month.

3. TAXES

The Lessee will pay any Sales, Use Tax, or Import Tax. XDS will pay the Personal Property Tax.

4. INSTALLATION PERMITS

Lessee will prepare the site in accordance with XDS's written site specifications 15 days prior to the scheduled delivery date. XDS will install the equipment. Lessee will provide labor for unpacking and locating the equipment. Lessee will assume responsibility for compliance with local laws and will obtain any permits required for installation and use.

5. SOFTWARE

XDS software identified as "Control Programs" will be provided by XDS under the terms of this equipment lease agreement; maintenance service will be provided for standard, current versions of such Control Programs.

XDS software identified as "Program Products" are not furnished under this agreement. Program Products will be made available to the Lessee on a fee basis pursuant to an XDS software licensing agreement executed by the Lessee.

6. MAINTENANCE

During the Regular and Extended Service Hours shown on the face of this agreement XDS will accomplish regularly scheduled preventive maintenance, provide replacement parts as needed, and make available, upon request, maintenance personnel for corrective maintenance.

Maintenance occasioned by the negligence of the Lessee, or by the use of attachments not provided by XDS, or by any abnormal use, is not covered by the monthly charge and Lessee agrees to pay for such services at XDS's then current rate.

The Lessee agrees to give XDS access to the equipment when necessary for maintenance.

If the face of the agreement indicates Optional Local Service is to be provided, XDS will locate one or more service technicians within 100 miles of the installation.

If Optional Local Service is not to be provided and the installation is beyond 100 miles from an XDS service center, Lessee agrees to pay transportation, lodging and subsistence for all calls in excess of one per week.

Lessee will pay for Maintenance Services requested to be performed outside the Regular and Extended Service Hours defined on the face of this agreement at the hourly rates, including travel time, in effect at the time such service is performed. There is a two hour minimum for all services performed on an hourly basis.

If the equipment remains inoperative for 48 consecutive hours after maintenance service has been requested, rental of the inoperative equipment and non-usable interconnected XDS equipment will thereafter abate until operation is restored. This rental abatement expresses XDS's entire liability for inoperative equipment. Lessee will pay the full amount of invoices submitted by XDS 30 days after their date, without deducting rental abatement or other credits until XDS and Lessee agree on the amount of the credit and XDS issues a credit memo in the agreed upon amount. Claims for downtime must be initiated in writing within seven (7) working days after the incident.

7. DELAYS, DAMAGES

XDS shall not be liable for delays in delivery or failure to manufacture due to causes beyond its reasonable control. In the event of any such delay, the date or dates for performance of this contract by XDS shall be extended for a period equal to the time lost by reason of delay. In no event shall XDS be liable for incidental or consequential damages under this lease.

8. ALTERATIONS, ATTACHMENTS

No alterations or attachments to the leased equipment shall be made without XDS's written approval.

9. TRANSPORTATION AND PACKING

Lessee will pay all transportation and rigging charges to and from the installation site and will return the equipment to XDS's plant by air freight, or by van equipped for transporting electronic equipment, unless XDS has approved in writing an alternate method of shipment. Lessee will not move the equipment to another location without XDS's consent.

10. OPTION

Lessee may purchase any of the leased equipment during the term of this lease for its sales price on the date of this lease less 40% of the rentals paid to a maximum of 60% of the sales price.

11. PATENT INDEMNITY

XDS agrees to defend Lessee in any suit brought against him alleging that the articles leased hereunder, uncombined with non-XDS equipment, directly infringe United States Letters Patent owned by others, provided XDS is promptly notified, given assistance required and permitted to direct the defense. Further, XDS will pay any judgment, based on such infringement, rendered in such suit by final judgment of a court of last resort, but shall not be responsible for settlements or costs incurred without its consent. If Lessee's use of such articles is enjoined, or in the event that XDS desires to minimize its liabilities hereunder, XDS will, at its option, either substitute other equally suitable articles, modify the articles so that they no longer infringe, obtain for Lessee the right to continue their use, or take them back releasing Lessee from the obligation of paying rentals not yet due. The foregoing states the entire liability of XDS for patent infringement. No indemnity shall apply to articles made or modified to Lessee's own specifications or design.

12. ASSIGNMENT

Either party may assign its rights and remedies and may also transfer its obligations under this lease. However, the assignment or transfer shall not operate to relieve the assigning party of any of its obligations hereunder. Nor will any such assignment impose any obligation on the assignee except in the case of an express written assumption thereof by the assignee.

13. LOSS OR DAMAGE

XDS agrees that Lessee shall be relieved of all responsibility for any loss or damage to the equipment covered by this agreement, provided that such loss or damage shall not have been caused by theft, unauthorized alteration, negligence or malice of the Lessee or any of its employees or representatives. The Lessee agrees to fully compensate XDS for any loss or damage to the equipment for which Lessee is not relieved of responsibility hereunder.

14. DEFAULT

In the event of any default by Lessee, XDS may, at its option, declare this lease in default and terminate this lease.

If at any time during the Lease Term or any extension thereof, Lessee shall make an assignment for the benefit of creditors or shall become insolvent, or if a receiver or trustee of substantially all of Lessee's property shall be appointed, or if the Lessee (where it is a corporation) shall terminate its existence, or if a petition is filed by or against Lessee pursuant to any of the provisions of the United States Bankruptcy Act, as amended, for the purpose of adjudicating Lessee bankrupt or for reorganization of Lessee or for the purpose of effecting an arrangement or composition with Lessee's creditors, then in each and every such case this lease and any extension thereof shall terminate immediately without any further act or notice by XDS.

Upon termination of the lease pursuant to this Article 14, XDS shall be entitled to immediate possession of the equipment and to any rental sums due and unpaid, together with all other rights and remedies in law or in equity.

Xerox Data Systems

XEROX.

MAINTENANCE AGREEMENT

NAME OF OWNER

STREET ADDRESS

CITY STATE ZIP CODE

INSTALLATION NO.

MAIN FRAME S/N

Agreement between ______ (hereinafter called Owner) and Xerox Data Systems (hereinafter called XDS) for the maintenance of XDS computer system and peripheral equipment per the configuration list and maintenance fees listed in Appendix A, in accordance with the terms and conditions of this contract.

This Agreement is for a fixed period of 7 Years commencing June/July, 1973.

XDS agrees to perform the following basic monthly maintenance service during the Principal Period of Maintenance.

1. Accomplish regularly scheduled Preventive Maintenance.

2. Update the equipment to provide the latest reliability improvements.

3. Supervise the preparation for movement and set-up of the equipment after movement.

4. Provide replacement parts as needed.

5. Make available, upon request, maintenance personnel for corrective maintenance.

A. PRINCIPAL PERIOD OF MAINTENANCE

The Principal Period of Maintenance (PPM) shall be any nine (9) consecutive hours, 7:00 a.m. and 6:00 p.m. (Monday through Friday), with a one (1) hour meal period.

B. EXTENDED COVERAGE

For contracted coverage of more than one shift, the PPM may be extended in the time increments and for the charges shown in the following schedule. The percentage is computed on the total monthly maintenance rate. The hours shown include the Principal Period of Maintenance.

Hours	5 Days	6 Days	7 Days
8	100%	120%	140%
16	140%	170%	190%
24	210%	225%	240%

C. PPM SERVICE HOURS

PPM service hours will be 8:30 am to 5:30 pm Monday through Friday, excluding holidays, with one (1) hour meal period.

Agreed to this

______ day of ______, 19____

Name of Owner

Street Address

City State Zip Code

By

If installation is beyond 100 miles from an XDS service center, the owner agrees to pay transportation, lodging and subsistence for all calls in excess of one (1) per week.

D. OPTIONAL LOCAL MAINTENANCE

The owner whose installation is located more than 100 miles from the nearest XDS service center may reduce the travel charges for which he is liable and diminish the response time by contracting for an XDS Field Engineering Representative to be located within 100 miles of the installation. The price for this relocation is:

1. $1,000 per month if XDS is maintaining only one (1) computer in the area.

2. $300 per month if XDS is maintaining two (2) computers in the area.

3. No charge if XDS is maintaining three (3) or more computers in the area.

XDS ☐ shall, ☐ shall not locate one or more service technicians within 100 miles of the installation.

E. CHARGES

(1) Basic monthly charge per Appendix A	3,944.00
(2) Extended coverage	N/A
(3) Optional local service	N/A
Sub-Total	3,944.00
Quantity Discount	930.40
Total Maintenance Charge	253,142.40
Monthly Maintenance Charge	3,013.60

F. EMERGENCY SERVICE

Calls outside the PPM service hours defined in Paragraph C will be provided for at the following rates: Monday through Saturday, except holidays, $ 32.00 per man hour including travel time; Sunday and holidays $ 35.00 per man hour including travel time. There is a two (2) hour minimum for all services performed on an hourly basis.

When requested, XDS will provide off-site stand by service outside of the Principal Period of Maintenance at the rate of one (1) man hour for each four (4) hours of stand by. On-site stand by to be charged on a per hour basis.

Approved and Accepted

______ day of ______, 19____

Xerox Data Systems
701 South Aviation Blvd., El Segundo, California 90245

By

AGREEMENT CONDITIONS

1. GENERAL

Equipment not under XDS lease or maintenance contract immediately prior to the effective date of this maintenance agreement shall be subject to inspection by XDS without charge. If the equipment is not in good operating condition, labor and parts required to place the equipment in good operating condition shall be provided by XDS at the Owner's expense.

2. DURATION OF AGREEMENT

Addendum A is included by Reference

The Owner shall have the right to terminate this Agreement at any time after the first anniversary of the Commencement Date shown on its face, by written notice sent to and received by XDS at least three (3) months prior to the termination date selected by the Owner.

XDS may terminate this Agreement, or change the monthly maintenance or emergency service charge on any or all of the items of equipment covered by this Agreement at any time after the first anniversary of the Commencement Date, by written notice to the Owner three (3) months prior to the effective date of such termination or change. After receipt of notification of any such changes of maintenance charges, the Owner shall have the right to terminate this Agreement, such termination to become effective as the date of the proposed change in maintenance charges, provided that the Owner gives at least 30 days notice of such termination.

3. MONTHLY CHARGES AND TERMS OF PAYMENT

(a) The basic monthly charges for maintenance service shall begin on the Commencement Date shown on the face of this Agreement. For the calendar month in which service starts the charges shall be prorated to the end of the month and thereafter shall be invoiced for each calendar month on the first day of the month.

(b) The Owner agrees to pay the monthly and hourly charges as set forth on the face of this Agreement and to pay an additional amount equal to any taxes, however designated, levied, or based on such monthly charges or upon this Agreement, or any taxes or amounts in lieu thereof paid by XDS or payable by XDS in respect to the foregoing, exclusive of taxes based upon XDS' net income.

(c) Terms 30 days net from date of invoice.

4. RESPONSIBILITIES OF XDS

(a) XDS shall provide maintenance (labor and parts) at the price agreed to and keep the equipment in good operating condition.

(b) Preventive (scheduled) maintenance shall be performed at a time other than the Owner's working hours so long as it is performed during or contiguous to the Principal Period of Maintenance. XDS shall specify in writing the frequency and duration of the preventive maintenance required for the equipment listed on the order and the Owner shall specify the schedule for the performance of the preventive maintenance. This schedule may be modified by mutual agreement.

(c) Remedial maintenance shall be performed after notification that the equipment is inoperative. XDS shall provide the Owner with a designated point(s) of contact and make arrangements to enable his maintenance representative to receive such notification.

(d) XDS shall furnish a malfunction incident report to the installation upon completion of each maintenance call. The report shall include, as a minimum, the following:

(1) Date and time notified.
(2) Date and time of arrival.
(3) Type and model number(s) of machine(s).
(4) Time system made available to XDS.
(5) Time spent for repair.
(6) Description of malfunction.
(7) Corrective action taken including parts used.
(8) Additional charges, if applicable

(e) Only new standard parts or parts of equal quality shall be used in affecting repairs. Parts which have been replaced shall become the property of XDS.

(f) Maintenance service shall include the items of equipment necessary to the maintenance of the machine being serviced.

(g) XDS sponsored modifications to equipment which are made to rented equipment of the same type as being maintained under the terms of this contract shall be made with the consent of and without charge to the Owner.

5. RESPONSIBILITIES OF OWNER

(a) The Owner shall provide adequate storage space for spare parts and adequate working space, including heat, light, ventilation, electric current and outlets for the use of XDS' maintenance personnel. These facilities shall be within a reasonable distanc

(b) The Owner's personnel shall not perform maintenance or attempt repairs to equipment while such equipment is under the purview of this contract unless agreed to by XDS.

(c) The Owner shall provide XDS access to the equipment to perform maintenance services. If additional costs are incurred as a result of the Owner's denial of access during the scheduled periods for an unreasonable period of time, the Owner shall bear the cost of returning the equipment to good operating condition.

6. MAINTENANCE

(a) XDS agrees to make available, upon request, maintenance personnel for corrective maintenance. Additionally, if the service is begun during the Principal Period of Maintenance and the difficulty is not corrected on the same day at the end of the PPM service will continue at no extra charge.

(b) The Principal Period of Maintenance or extension thereof may be changed by the Owner upon 30 days written notice.

(c) Corrective maintenance occasioned by the negligence of the Owner, his employees or representatives, or by the use of devices or special attachments not provided by XDS or by any other misuse or abnormal use, is not covered by the monthly charge.

(d) There shall be no additional maintenance charges for time spent by maintenance personnel after arrival at the site awaiting the arrival of additional maintenance personnel and/or delivery of parts, etc., after a service call has commenced.

7. ALTERATIONS AND ATTACHMENTS

If the owner makes alterations or installs attachments to the equipment covered by this Agreement, and if in the opinion of XDS the cost of maintenance is substantially increased, the parties may mutually adjust the maintenance charge for the equipment or XDS may immediately discontinue service for such equipment hereunder.

8. MOVEMENT OF EQUIPMENT

(a) In the event that equipment being maintained under the terms and conditions of this Agreement is moved to another location, XDS shall continue to maintain the equipment at the new location unless such a movement should remove the equipment outside the 48 contiguous states and the District of Columbia.

(b) In the latter instance, the maintenance agreement shall be terminated without further obligations being incurred by either XDS or the Owner.

(c) The Owner shall give at least 30 days written notice of the movement of equipment unless such move is required because of an emergency.

(d) When the shipment is under the control of XDS and damage is incurred which results in abnormal costs for either labor or parts to restore the equipment to good operating condition at the new site, such costs shall be borne by XDS.

(e) When the shipment is under the control of the Owner and damage is incurred which results in abnormal costs for either labor or parts to restore the equipment to good operating condition at the new site, such costs shall be borne by the Owner.

(f) Maintenance charges shall be suspended on the day the equipment is dismantled in preparation for shipment. Maintenance charges shall be reinstated on the day installation and checkout procedure necessary to place the system in good operating condition are complete.

(g) The Owner shall furnish transportation and such labor as may be necessary for packaging and placement of the equipment. Re-installation and checkout charges may be negotiated with XDS.

9. LIABILITY FOR INJURY OR DAMAGE

XDS shall be liable for any injury to the Owner's personnel or damage to the Owner's property arising from the use of the equipment maintained by XDS when such injury or damage is due to the fault or negligence of XDS. The Owner shall be liable for any injury to XDS personnel or damage to XDS property when such injury or damage is due to the fault or negligence of the Owner.

10. SPECIFIC CONTRACT COMMITMENTS

No representations or statements made by any representative of XDS which are not stated herein shall be binding. The provisions hereof constitute the entire Agreement between the parties with respect to the equipment and its maintenance. The terms and conditions of this Agreement supersede those of all previous agreements between the parties with respect to the equipment covered by this Agreement.

APPENDIX A

EQUIPMENT LOCATION ADDRESS CITY STATE ZIP CODE

ITEM	MODEL NO	QTY.	DESCRIPTION	UNIT CHARGE*	TOTAL
1	8310C	1	Sigma 6 CPU	1,792	1,792
2	8318	1	Floating Point Arithmetic Unit	103	103
3	8321	1	Interrupt Control Chassis	30	30
4	8322	1	Priority Interrupt, 2 Levels	NC	NC
5	8375	1	IOP Expansion Feature	98	98
6	7315	1	Magnetic Tape Controller & Drive	286	286
7	7316	1	Add-on Tape Transport	180	180
8	7122	1	Card Reader	127	127
9	7165	1	Card Punch	140	140
10	7441	1	Line Printer	292	292
11	7240	1	Disk Controller	104	104
12	7242	1	Dual Spindle Disk Drive	281	281
13	7012	1	Operators Console	48	48
14	7612	1	Timing Modules	NC	NC
15	7630	1	Communications Controller with 8 Lines	47	47
16	7631	2	Eight Line Expansion Unit	31	62
17	7231	1	RAD Controller	73	73
18	7232	1	6. 3 MB RAD Storage	265	265
19	7235	1	Extended Width Feature	16	16

*Based on 8 hours, Mon. Through Fri.

ADDENDUM A TO MAINTENANCE AGREEMENT

Between XEROX CORPORATION and

WAYNE COUNTY COMMUNITY COLLEGE

The subject lease is amended to delete Paragraph 2, DURATION OF AGREEMENT and to add the following:

"2. DURATION OF AGREEMENT

This Agreement shall be non-cancellable during the term specified on the face of this Agreement, and shall continue on a month-to-month basis until cancelled by either party to this Agreement. Written notice of intent to terminate this Agreement shall be provided at least three (3) months prior to the termination date selected.

Xerox shall have the right during the specified term and thereafter to increase the monthly maintenance and emergency service charges on any or all items of equipment covered herein at any time after the first twelve (12) months by written notice to the Owner at least three (3) months prior to the effective date of such change. Such increase, however, shall not exceed five (5) percent per annum of the total monthly rate charged for maintenance of the system."

AGREED TO THIS	ACCEPTED THIS
________ day of ________ 19 __	________ day of ________ 19 __
	Xerox Data Systems 701 South Aviation Boulevard El Segundo, California 90245
____________ Lessee	
____________ By	____________ By
____________ Title	____________ Title

TIME SALE AND SECURITY AGREEMENT

XEROX CORPORATION, a New York corporation, acting through its Xerox Data Systems division, 701 South Aviation Boulevard, El Segundo, California 90245 (hereinafter called "SELLER") and ____ (hereinafter called "BUYER") agree as follows:

1. Sale and Purchase. SELLER hereby sells to BUYER, and BUYER hereby purchases from SELLER the several items of equipment listed and described in Schedule A attached hereto and made a part hereof (the "Equipment"), upon the terms and conditions provided herein, and for the Time Sale Price specified with respect thereto on Schedule A, payable as provided in Section 3, but subject to acceleration as provided in Section 9.

2. Security Interest; Transfer of Title. BUYER hereby grants to SELLER a security interest in the Equipment and any and all replacements and substitutions thereof and repairs thereto, for the purpose of securing the payment of the balance of the Time Sale Price from time to time due hereunder and all other liabilities of BUYER to SELLER arising under this Agreement. Title to each item of Equipment shall upon delivery of each such item at the location specified by BUYER pass to BUYER.

3. Payment of Purchase Price. Subject to the provisions of Section 9, the Time Sale Price with respect to each item of Equipment will be paid by BUYER to SELLER in 34 consecutive monthly installments in the amount set forth in Schedule A, such installments to be paid on the first day of each month commencing on June/July 1973.

4. Delivery and Acceptance; Risk of Loss. Delivery of the Equipment shall be made at BUYER's expense to such location in the United States as BUYER shall specify, shipment to be made by SELLER within six (6) months after receiving written notice to deliver from BUYER. Possession of each item of Equipment and the risk of loss thereof or damage thereto shall pass to BUYER upon his acceptance thereof. Such acceptance shall be deemed to occur upon delivery of the Equipment to the location specified. SELLER shall install the Equipment at the location specified in BUYER's written notice, such installation to be in the manner and to include documentation, standard software, and software support normally supplied to customers of SELLER without charge. SELLER shall not be liable for delays in delivery or failure to manufacture due to acts beyond its reasonable control, including but not limited to acts of God, acts or omissions of civil or military

authority, priorities, fire, strikes, floods, restrictions, riots, war, delays in transportation, car shortages, and inability due to causes beyond its control to obtain the necessary labor, materials or manufacturing facilities. In the event of any such delay, the date for performance of this Agreement by SELLER shall be extended for a period equal to the period of time lost by reason of the delay.

5. Taxes. BUYER acknowledges that it is not purchasing the Equipment for resale. All taxes of every description (including sales, use and personal property taxes) arising out of the transactions contemplated hereby (other than taxes on the income of SELLER) shall be borne and paid for solely by BUYER, and BUYER shall pay or shall reimburse SELLER for its payment of any applicable personal property tax with respect to the Equipment accrued after the date hereof.

6. Financing Statement. At the time of execution of this Agreement, BUYER will join with SELLER in executing and filing appropriate financing statements relating thereto in form satisfactory to SELLER. Further, promptly upon delivery and acceptance of each item of Equipment as provided in Section 4, or upon any subsequent relocation of any item of Equipment, BUYER will join with SELLER in executing and filing such further financing statements relating thereto in form satisfactory to SELLER and as SELLER may deem appropriate.

7. Insurance. From the time at which the risk of loss or damage to the Equipment passes to BUYER as provided in Section 4 hereof, BUYER shall procure and maintain, with an insurance carrier acceptable to SELLER, insurance thereon against such risks and in such amounts as SELLER shall reasonably require. Each such policy of insurance shall be endorsed with a standard mortgagee or security certificate or certificates of the insurance carrier or carriers evidencing insurance coverage as herein required.

8. Mutual Covenants and Agreements. SELLER hereby covenants and agrees (i) that it is now and upon delivery and acceptance of any of the Equipments as provided in Section 4 hereof, it will be the owner of such Equipment, free and clear of any and all liens, encumbrances, claims, or security interests other than those to be created hereby, and other than any lien, encumbrance, claim or security interest on or against the Equipment heretofore or hereafter caused or allowed to be caused by BUYER or any subsidiary or affiliated company of BUYER; (ii) that it has now and will then have the full right and power to sell the Equipment to BUYER upon the terms and conditions provided herein; and (iii) that so long as BUYER shall not be in default hereunder and subject to the rights of any third party as a result of any lien, encumbrance, claim, or security interest on or against the Equipment caused or allowed to be caused by BUYER or any subsidiary or affiliated

company of BUYER, BUYER shall be entitled to the sole and exclusive possession and use of the Equipment purchased by and delivered to it hereunder. BUYER hereby covenants and agrees (i) that it now has and that upon delivery and acceptance of any of the Equipment as provided in Section 4 hereof it will have the full right and power to buy the Equipment from SELLER upon the terms and conditions provided herein; (ii) that it will not use or deal with the Equipment in a manner which is inconsistent with the terms of this Agreement, or any policy of insurance referred to in Section 7 hereof, or the applicable laws and regulations of governmental agencies; and (iii) that it will not use the Equipment in any manner which results in unreasonable deterioration or depreciation thereof, and that SELLER shall have the right to inspect the Equipment at any reasonable time, wherever located.

9. Acceleration; Prepayment. (a) Upon any acceleration of the maturity of its obligations with respect to any item of Equipment pursuant to this Section 9 (the Acceleration Date), the BUYER shall pay to the SELLER an amount (the Acceleration Price) which shall be equal to (i) the portion of the Invoice Price of such item (as set forth in Schedule A hereto) which would remain unpaid on the Acceleration Date if such Invoice Price had been borrowed and partially repaid in installments in the same amounts and payable on the same dates as the installments of the Time Sale Price heretofore paid by BUYER for such item and if each such installment payment had been applied first to the payment of interest on such unpaid portion at a rate of six (6) percent per annum and the remainder to the Invoice Price, and (ii) interest (computed at six (6) percent per annum rate from the date of the last preceding installment paid hereunder to the Acceleration Date) on the Invoice Price remaining unpaid as arrived at in (i).

(b) BUYER shall give SELLER not less than fifteen (15) days written notice of any proposed resale or lease of any item of Equipment during the term of this Agreement. Such notice shall state the item or items of Equipment to be resold or leased and the date upon which sale or lease is to be effective. If the Equipment is to be resold or leased, BUYER shall pay to SELLER on or prior to such date the Acceleration Price in respect of such item of Equipment.

(c) If at any time an event of default specified in Section 10 hereof shall have occurred and shall be continuing, SELLER shall have the right, upon written demand to BUYER specifying such event of default, to require BUYER to pay, within ten (10) days after the date of such demand, the Acceleration Price with respect to all of the Equipment then subject hereto.

(d) If any item of the Equipment shall be substantially destroyed or shall be damaged beyond repair, SELLER shall have the right, upon written demand to BUYER, to require BUYER to pay, within ten (10) days after the date of such demand, the Acceleration Price with respect to each item of Equipment so destroyed or damaged, less any proceeds of insurance theretofore received by SELLER with respect to such Equipment.

(e) BUYER shall have the right, exercisable at any time during the term of this Agreement, upon written notice to SELLER specifying the items of Equipment affected, to fully satisfy its obligations hereunder with respect to any or all items of Equipment by the payment to SELLER, not less than ten (10) days nor more than thirty (30) days after the date of such written notice, the Acceleration Price with respect to such items of Equipment. SELLER agrees, on request of BUYER, to confirm in writing to any proposed purchaser or lessee of any of the Equipment from BUYER that, on payment in full to SELLER of the Accelerated Purchase Price, the amount of which Accelerated Purchase Price shall be specified in such notice, SELLER will release its security interest in the Equipment.

(f) SELLER shall release its security interest in any item of Equipment when payment shall have been made with respect thereto as provided in this Section 9, and shall execute such documents furnished by BUYER as may be necessary to evidence such release.

10. Events of Default; Remedies. BUYER shall be in default (a) if it shall fail to pay, or cause to be paid, any installment payable under Section 3 hereof, or any sum payable upon any acceleration under Section 9 hereof when the same is due, or (b) if it shall fail to perform any other term or condition of this Agreement, and such failure shall continue for a period of fifteen (15) days after written notice thereof from SELLER to BUYER, or (c) if Federal bankruptcy, insolvency, liquidation, receivership or like proceedings are initiated by or on behalf of or against BUYER, or any of the Equipment shall be attached, seized or levied upon, and such proceedings, attachment or levy shall not be vacated or fully stayed, within thirty (30) days after the institution or occurrence thereof, or (d) if any of the Equipment shall be sold, leased or encumbered by BUYER other than in accordance with the provisions of Section 9 (b) hereof.

If an event of default shall have occurred and be continuing, SELLER shall have the right to accelerate BUYER's obligations hereunder as provided in Section 9 (e) hereof, and in addition shall have all the rights (not inconsistent with the rights specifically provided herein) of a secured party under the Uniform Commercial Code; or SELLER may, at its option, and it is hereby empowered so to do, enter upon the premises where the Equipment may be and take possession thereof, or remove, sell and dispose of the Equipment and from the proceeds of sale retain all costs and charges incurred by SELLER in the taking or sale of the Equipment including any reasonable attorney's fees thereby incurred; also SELLER may take all sums due it under the terms of this Agreement including reasonable attorney's fees; and any surplus of such proceeds remaining shall be paid to BUYER. The foregoing is without limitation to or waiver of any other rights or remedies of SELLER according to law. It is further agreed that upon any sale of the Equipment according to law, or under the power herein given, that SELLER may bid on the said sale, or make a purchase of the Equipment or any part thereof.

11. Waivers. A waiver by SELLER of a default under this Agreement shall not operate as a waiver of any other default which may thereafter occur.

12. Location of Equipment. Following delivery and acceptance thereof as provided in Section 4, and so long as the Equipment is subject to a security interest of SELLER, the Equipment will be kept at the location specified in BUYER's written notice or at such other location as may hereafter be agreed upon by SELLER and BUYER; during such period BUYER will promptly notify SELLER of any change in the location of the Equipment, and will not remove the Equipment from the aforesaid location, without the prior written consent of SELLER which consent shall not be unreasonable withheld or delayed.

13. Warranty. SELLER warrants that the Equipment is merchantable and that it will replace or repair any components of Equipment manufactured by SELLER which are defective by reason of material or workmanship that the BUYER returns to SELLER within one (1) year from acceptance of the Equipment. This warranty does not extend to program products, nor to expendable items such as pilot lamps and fuses, nor to components that have suffered mechanical wear, such as vacuum motors and punch die blocks, nor to products altered or repaired by personnel other than those employed by SELLER, or trained and certified by SELLER. Shipment of defective parts to SELLER will be paid by BUYER. Return shipment, to the BUYER, of repaired or replaced parts will be paid by SELLER. Operation or storage of the Equipment in an environment other than that selected by SELLER or recommended by SELLER's published specification will invalidate this warranty. There are no other warranties, expressed or implied. In no event shall SELLER be liable for incidental or consequential damages.

14. Patent Indemnity. SELLER agrees to defend BUYER in any suit brought against it alleging that any item of the Equipment sold hereunder uncombined with equipment other than that manufactured by SELLER, directly infringes United States Letters Patent owned by others, provided SELLER is promptly notified, given assistance required, and permitted to direct the defense. Further, SELLER will pay any judgment based on such infringement, rendered in such suit by final judgment of a court of last resort but shall have no liability for statements or costs incurred without its consent. If BUYER's use of any item of Equipment is enjoined, or in the event that SELLER desires to minimize its liabilities hereunder, SELLER will, at its option, either substitute

other equally suitable items of the Equipment, modify such items so that they no longer infringe, obtain for BUYER the right to continue their use, or take them back returning the price less a reasonable amount for use, damage and obsolescence. The foregoing states the entire liability of SELLER for patent infringement. No indemnity shall apply to items of the Equipment made or modified to BUYER's own specifications or design.

15. Notices. All notices or other communications required or permitted to be given pursuant to this Agreement shall be in writing and shall be valid and sufficient if delivered by hand or dispatched by registered or certified airmail, postage prepaid, addressed as follows:

Xerox Data Systems
701 South Aviation Boulevard
El Segundo, California 90245
Attention: Vice President-Finance

or to such other address as either party shall notify the other in writing. Given notices dispatched by registered or certified airmail shall be deemed to have been given three days after such notice is deposited in any post office.

16. Governing Law; Severability. This Agreement shall be construed in accordance with and governed by the internal laws of the State of California. Any provision of this Agreement which may be prohibited by law shall be ineffective to the extent of such prohibition without invalidating the remaining provisions of this Agreement.

17. Equipment Markings. SELLER may mark the Equipment to conspicuously show that it has a security interest therein and BUYER shall place no conflicting marks or indicia on the Equipment or suffer SELLER's marks to be removed or defaced without the written consent of SELLER or until payment in full shall have been made and BUYER shall have fulfilled all of its obligations hereunder.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the ____________

____________________ day of ____________________, 1973

XEROX CORPORATION
XEROX DATA SYSTEMS

By ____________________	By ____________________
____________________ Typed Name	____________________ Typed Name
____________________ Title	____________________ Title

SCHEDULE A

Quantity	Catalog No.	Description	Invoice Price	Down Payment	Monthly Installment *
1	8310C	Sigma 6 CPU	228,800		
1	8318	Floating Point Arithmetic	20,000		
1	8321	Interrupt Control Chassis	1,760		
1	8322	Priority Interrupt	280		
1	8375	IOP Expansion Feature	14,000		
1	7315	Controller and one transport	25,200		
1	7316	Add-on Transport	10,800		
1	7122	Card Reader	14,400		
1	7165	Card Punch	17,640		
1	7441	Line Printer	41,400		
1	7240	Disk Controller	18,000		
1	7242	Dual Spindle Disk	22,500		
1	7012	Operators Console	5,400		
1	7612	Timing Module	200		
1	7630	Communications Control and 8 Lines	11,200		
2	7631	Eight Line Expansion Units	9,280		
1	7231	RAD Controller	11,200		
1	7232	RAD (6.2MB)	30,000		
1	7235	Extended Width Interface	2,000		
			484,060		

* The Monthly Installment is equal to the Invoice Price (I. P.) less the Down Payment (0 % of I. P.) times .0146 , the factor appropriate to amortize a loan in eighty-four (84) equal monthly installments at six percent per annum on the unpaid balance).

** The Time Sale P rice is equal to the sum of the 84 Monthly Installments plus the Down Payment.

SECTION VIII

VIII. MEMORY EXPANSION OPTIONS

	Core Size In Words	Model	Gross Purchase	Educational Discount	Net Purchase	Expansion Charge
From	64K	8310C				
To	80K	8310D	21,000	4,200	16,800	2,600
From	80K	8310D				
To	96K	8310E	21,000	4,200	16,800	2,600
From	96K	8310E				
To	112K	8310F	21,000	4,200	16,800	2,600
From	112K	8310F				
To	128K	8310G	21,000	4,200	16,800	2,600

Note: Expansion Charges are additive.

APPENDIX M

(Intentionally Omitted)